# THE PHYSICAL REVIEW

VOLUME 176 *Second Series* INDEX

DECEMBER 1968

*Published for*

THE AMERICAN PHYSICAL SOCIETY

*by the*

AMERICAN INSTITUTE OF PHYSICS

LANCASTER, PA., AND NEW YORK, N. Y.

# Information for Contributors

Send manuscripts to the Editors, *The Physical Review*, Brookhaven National Laboratory, Upton, N. Y. 11973.

Consult recent issues of this journal and the American Institute of Physics **Style Manual** (second revised edition, 1967) for the general format and style of articles. Specify section and index categories. [See Phys. Rev. 153, 1728 (1967).]

The **manuscript**, including the abstract, references, and captions should be neatly typed in English, double spaced on good letter-size (8½ in. × 11 in.) white paper with ample margins to allow for editorial marking. It should be carefully proofread by the author for misspellings, grammatical errors, and missing symbols. Unclear or excessive handwritten insertions are not acceptable. A **duplicate** copy of the manuscript must be furnished.

The **title** should be concise but informative enough to facilitate information retrieval. The **abstract** should be self-contained for reprinting in Abstract Journals. It should be adequate as an index (giving all subjects, major and minor, about which new information is given) and as a summary (giving the conclusions and all results of general interest in the article). It should be about 5% of the length of the article but less than 500 words.

**Equations** should be neatly typed or written in ink, punctuated and aligned to bring out their structure, and numbered on the right. Mathematical operation signs indicating continuity of the expression should be placed at the left of the second and succeeding lines.

**Notation** should be chosen so as to be clear, compact, and consistent with standard usage. The prime requisite is that the copy be as clear as possible to the typesetter, who is neither a physicist nor a mathematician. To this end a certain amount of editorial copymarking is necessary. All unusual symbols should be identified the first time they are used, and at subsequent times when confusion might arise. Boldface symbols should be marked by a wiggly black underline always. Handwritten symbols should be identified as capital or lower case. Handwritten Greek symbols should be identified in the margin the first time and underscored in red later if confusion is possible. (This is particularly important for those symbols such as $\chi$ or $\kappa$ which may look, when handwritten, like italic symbols, $x$ or $k$; or for capital $\Sigma$ and $\Pi$ which can be confused with the summation or product symbols, themselves oversize special characters.) German, script, or sans-serif letters should be identified the first time in the margin and later underscored in green if they may be confused with other letters.

Because of the monotype system of typesetting used by *The Physical Review*, in which each character, on a separate piece of type, can only be placed adjacent to and not above or below another character, certain expressions cannot be handled. Superscripts cannot be placed above subscripts. In fact, superscripts should be placed after subscripts except where the meaning would be affected (e.g., in general relativity). Where there is doubt as to the position of the superscript or subscript, a sharp black-pencilled caret or inverted caret should be used to indicate the position. Bars cannot be placed over more than one symbol. Where the bar denotes an average we usually recommend the notation $\langle\ \rangle_{\text{Av}}$ and where the bar is part of a root sign we require the use of fractional exponents. Also, special markings such as tildes, bars, carets, and dots cannot be placed over symbols unless that symbol with the appropriate marking already exists as a separate piece of type.

A list of the **available symbols** is given on pp. 21 through 26 of the AIP *Style Manual*. Note that if a symbol is available "on the line" it is not necessarily available as a superscript or subscript unless specifically indicated.

The solidus should be used instead of built-up fractions to save vertical space where clarity would not be jeopardized. This is of particular importance in the running text. Also the "exp" notation should be used where complicated exponents exist.

**References** *including comments* must be numbered consecutively in order of first appearance in the text and should be given in a separate double-spaced list at the end of the text material. References to tables should be designated by lower case roman letters and given at the end of the table. The proper form for references will be found on p. 7 of the AIP *Style Manual* and in recent issues of this journal.

Numbered **tables** should be used for all but the simplest tabular material; they should have suitable captions which make the tables intelligible without reference to the text. The table structure should be clear, with simple column headings giving all units. The tables should be numbered in the order in which they are referred to in the text.

**Figures** should be planned for the 3-in. column width of *The Physical Review*. In some cases where the figures contain a great deal of detail, 1½ or 2 columns may be used. The lettering and data points on the figures should be large and clear enough so that they will be legible after reduction (the final size should be at least $\frac{1}{16}$ in. ~1.5 mm). Waste space at the top and bottom should be avoided. Figures should be numbered in the order in which they are referred to in the text. A separate list of captions should be supplied. The figure itself should have properly labeled axes with correctly abbreviated units. [For unit abbreviations see AIP *Style Manual*, pp. 9–11.] Figures should be identified on the back by the number, the name of the first author, and the journal.

Because of the zinc-etching or copper-halftone processes used in making figures, a maximum black-white contrast is necessary. We require original india-ink drawings or good, clear glossy prints. The latter are preferable to oversized originals. Avoid small open symbols which tend to fill in upon reduction, small dots which barely reproduce, and toned shading which fails to reproduce well in engraving. Photographs of apparatus are unacceptable and should be replaced by good schematic diagrams. For complete instructions on preparation of illustrations see AIP *Style Manual*, pp. 27–32.

After notification of acceptance, all correspondence regarding proofs, etc. should be addressed as follows: *Papers in Issue No. 1*: The Physical Review, 150 Central Ave., Farmingdale, L. I., N. Y. 11735; *Papers in Issues No. 2–5*: Supervisor, Editorial Department, American Institute of Physics, 335 East 45th Street, New York, N. Y. 10017. Reference *must* be made to journal, scheduled issue, title, and first author. Authors will be charged for alterations made in proof and, in the case of excessive alterations, the manuscript will be returned to the Editorial Office for reconsideration.

10-31-68

# THE

# PHYSICAL REVIEW

*A journal of experimental and theoretical physics established by E. L. Nichols in 1893*

VOLUME 176

*Second Series*

DECEMBER 1968

*Published for*

THE AMERICAN PHYSICAL SOCIETY

*by the*

AMERICAN INSTITUTE OF PHYSICS

# THE PHYSICAL REVIEW

*A journal of experimental and theoretical physics established by E. L. Nichols in 1893.*

Published by the
American Institute of Physics
for

**The American Physical Society**

**Officers**

*President*
JOHN BARDEEN
University of Illinois

*Vice-President*
L. W. ALVAREZ
University of California
Berkeley

*Vice-President Elect*
E. M. PURCELL
Harvard University

*Treasurer*
S. L. QUIMBY
Columbia University

*Executive Secretary*
W. W. HAVENS, JR.
Columbia University

*Secretary Emeritus*
K. K. DARROW
Bell Telephone Laboratories
(*retired*)

*Regional Secretaries:*

*Central States*
R. G. SACHS
Argonne National Laboratory

*Western States*
WARD WHALING
California Institute of Technology

*Editor in Chief*
S. A. GOUDSMIT
Brookhaven National Laboratory

*Office of the Society*

American Institute of Physics
335 East 45 Street
New York, N. Y. 10017

**Editors**

S. PASTERNACK A. W. K. METZNER J. R. ROESSER

*Assistants to the Editors*

J. C. FINEMAN R. W. JONES J. KERWIN H. E. LEMING

**Manuscripts** for publication should be submitted to the Editors, *The Physical Review*, Brookhaven National Laboratory, Upton, N. Y. 11973. The author's institutions are requested to pay a publication charge of $75 per page which, if honored, entitles them to 100 free reprints. An additional $10 will be requested for publication of the abstract in *Physical Review Letters* and *Physics Abstracts*. Instructions will be sent with galley proofs.

**Proof and all correspondence** concerning papers in the process of publication should be addressed as follows:

Papers in Issue No. 1: The Physical Review, 150 Central Ave., Farmingdale, L. I., N. Y. 11735.

Papers in Issues No. 2–5: Supervisor, Editorial Department, American Institute of Physics, 335 East 45 Street, New York, N. Y. 10017.

Reference must be made to title, author, journal, and scheduled date of publication.

**Annual Subscription Prices**

| | U.S.A., Canada, and Mexico | Elsewhere |
|---|---|---|
| Members of The American Physical Society: | | |
| Sec. 1 or 2 or 3 or 4 or 5 | $ 9.00 | $10.70 |
| All numbers | 36.00 | 44.50 |
| Nonmembers (all numbers only) | 50.00 | 58.50 |

(Only one copy of each index issue will be sent to each subscriber, regardless of the number of sections ordered.

**Back Numbers**

*Yearly back-number rate when complete year is available:*

| | |
|---|---|
| 1953 through 1963, inclusive | $48.00 |
| 1964 and thereafter | $65.00 |

*Single copies:* $2.00 each.

*Single copies of monthly Index issue (1964 and thereafter):* $2.00 each; semi-annual cumulative indexes: $2.00 each.

| | | | |
|---|---|---|---|
| *General index, 1921–1950:* | Paper binding, | $10 (Members); | $14 (Nonmembers) |
| | Cloth binding, | $12 (Members); | $16 (Nonmembers) |
| *Author index, 1956–1960:* | Paper binding, | $ 5 (Members); | $ 7 (Nonmembers) |
| *1961–1965:* | Paper binding, | $ 5 (Members); | $ 7 (Nonmembers) |

**Subscriptions, renewals, orders for back numbers, and changes of address** should be addressed to the Circulation Department, American Institute of Physics, 335 East 45 Street, New York, N. Y. 10017. For a change of address, allow at least six weeks' advance notice; send both old and new addresses and, if possible, please include an address stencil imprint from the mailing envelope of a recent issue.

**Permission** is granted to quote from this journal in scientific articles, with the customary acknowledgment of the source. Reproduction of figures and tables is permitted provided that the author's consent is obtained and that the editorial office is notified. Reproduction of whole articles for commercial purposes requires written permission of both Editor and author.

**The Physical Review is published five times a month (on the 5th, 10th, 15th, 20th, and 25th of each month), at Prince and Lemon Streets, Lancaster, Pa. 17604.**
**Second-class postage paid at Lancaster, Pa.**

# THE PHYSICAL REVIEW

*A journal of experimental and theoretical physics established by E. L. Nichols in 1893*

SECOND SERIES, VOL. 176, INDEX — DECEMBER 1968


## Analytic Subject Index for 1968

**Papers are indexed under the following headings. To assist in the location of specific items, an alphabetically arranged list with corresponding code numbers follows. The notation 5(2–5).1 means 52.1, 53.1, 54.1, and 55.1, etc.**

### 10 Atoms, Molecules, and Related Topics

11 Atomic Structure and Spectra (see also 15, 22, and 23)
- 11.2 Atomic Structure Theory
- 11.4 Fine and Hyperfine Spectra (see also 5(2–5).1)
- 11.6 X Rays (see also 42.1)

12 Molecular Structure and Spectra (see also 15)
- 12.5 Chemical Physics

13 Atomic and Molecular Collisions
- 13.2 With Incident Ions
- 13.4 With Incident Electrons

14 Radiative Processes; Polarization and Resonance; Bremsstrahlung (see also 21)

15 Positronium, Muonium, and Mesonic Atoms and Molecules (see also 25)

### 20 Atoms, Nuclei, and Particles in Matter

21 Magnetic Resonance (see also 14, 4(6–9).6, and 49.7)
- 21.2 Paramagnetic Resonance
- 21.4 Nuclear Resonance

22 Spectra of Ions

23 Stimulated Emission; Lasers and Masers (see also 44.4 and 62.4)
- 23.2 Gas
- 23.4 Solid

24 Recoilless Absorption and Gamma-Ray Emission

25 Positron Annihilation (see also 15)

26 Electron and Ion Emission (see also 42.2)

27 Range and Energy Loss (see also 13 and 43.2)

### 30 Fluids, Thermodynamics, and Related Topics

31 General Theory of Fluids (see also 41.1 and 51.4)

32 Fluid Structure, Properties, and Dynamics (see also 33 and 35.5)
- 32.2 Gases
- 32.4 Liquids

33 Thermodynamics and Statistical Physics (see also 42.4)
- 33.5 Irreversible, Transport, and Stochastic Processes (see also 45)

34 Liquid and Solid Helium (see also 31)

35 Plasmas (see also 41.1)
- 35.5 Gas Discharges (see also 13)

36 Atmospheric Physics (see also 61.2)

### 40 Solids

41 Collective Effects and Critical Phenomena (see also 4(6–9).1)
- 41.1 Electron Correlations; Plasma Effects (see also 35)
- 41.2 Critical Phenomena (see also 32.4 and 41.4)
- 41.3 Long-Range Magnetic Order (see also 49)
- 41.4 Superconductivity–Theory (see also 31)
- 41.5 Superconductivity–Experiment

42 Crystal Structure and Lattice Properties (see also 4(6–9).2)
- 42.1 Structure and Symmetries; Diffraction
- 42.2 Surfaces, Interfaces, and Films; Growth (see also 26)
- 42.3 Lattice Dynamics (see also 45)
- 42.4 Static Thermal and Mechanical Properties (see also 33)

43 Imperfections and Impurities; Alloys (see also 4(6–9).3)
- 43.1 Defects and Dislocations (see also 48.7)
- 43.2 Radiation Damage (see also 27)
- 43.3 Impurities (see also 43.5)
- 43.4 Atomic Diffusion and Mobility (see also 33.5)
- 43.5 Alloys (see also 43.3)

44 Electronic Structure and Properties (see also 4(6–9).4)
- 44.1 Electron States; Band Structure (see also 45)
- 44.2 Electric and Magnetic Susceptibilities and Polarizations (see also 49.8)
- 44.3 Optical Emission and Absorption (see also 11, 12, 22, and 48.7)
- 44.4 Optical Propagation and Properties (see also 23)

45 Transport Properties (see also 33.5 and 4(6–9).5)
- 45.1 Acoustical Propagation (see also 42.3)
- 45.2 Thermal Conduction (see also 42.3)
- 45.3 Electrical Conduction (see also 44.1)
- 45.4 Magnetotransport Effects (see also 44.1)

46 Metals and Semimetals (see also 49)
- 46.1 Collective and Critical Effects (see also 41)
- 46.2 Crystal Structure and Properties (see also 42)
- 46.3 Imperfections and Impurities; Alloys (see also 43)
- 46.4 Electronic Structure and Properties (see also 44)
- 46.5 Transport Properties (see also 45)
- 46.6 Atoms, Nuclei, and Particles in Metals (see also 20)
- 46.7 Semimetals

47 Semiconductors
- 47.1 Collective and Critical Effects (see also 41)
- 47.2 Crystal Structure and Properties (see also 42)
- 47.3 Imperfections and Impurities; Doping (see also 43)
- 47.4 Electronic Structure and Properties (see also 44)
- 47.5 Transport Properties (see also 45)
- 47.6 Atoms, Nuclei, and Particles in Semiconductors (see also 20)

48 Insulators (see also 34 and 49)
- 48.1 Collective and Critical Effects (see also 41)
- 48.2 Crystal Structure and Properties (see also 42)
- 48.3 Imperfections and Impurities; Amorphous Solids (see also 43)
- 48.4 Electronic Structure and Properties (see also 44)
- 48.5 Transport Properties (see also 45)
- 48.6 Atoms, Nuclei, and Particles in Insulators (see also 20)
- 48.7 Color Centers (see also 43.2)



Copyright © 1969 by The American Physical Society

49 Magnetic Materials and Ferroelectrics (see also 41.3)
- 49.1 Collective and Critical Effects (see also 41)
- 49.2 Crystal Structure and Properties (see also 42)
- 49.3 Imperfections and Impurities; Alloys (see also 43)
- 49.4 Electronic Structure and Properties (see also 44)
- 49.5 Transport Properties (see also 45)
- 49.6 Atoms, Nuclei, and Particles in Magnetic Materials (see also 20)
- 49.7 Ferro-, Ferri-, and Antiferromagnetic Resonance (see also 21)
- 49.8 Ferroelectrics (see also 44.2)

**50 Nuclei**

51 Nuclear Theory
- 51.2 Nuclear Structure
- 51.4 Nuclear Matter (see also 31)
- 51.6 Nuclear Reactions and Scattering (see also 65)

52 Nuclei with $A \leqslant 5$
- 52.1 Properties; Mass, Abundance, Moments, and Spin (see also 11.4 and 21.4)
- 52.2 Spectroscopy; Decay, Energy Levels, and Transitions
- 52.3 Nuclear Reactions and Scattering—of Photons
- 52.4 ——of Leptons
- 52.5 ——of Mesons and Hyperons
- 52.6 ——of Nucleons
- 52.7 ——of Deuterons and Tritons
- 52.8 ——of $He^3$ and $He^4(\alpha)$

53 Nuclei with $6 \leqslant A \leqslant 19$
- 53.1 Properties; Mass, Abundance, Moments, and Spin (see also 11.4 and 21.4)
- 53.2 Spectroscopy; Decay, Energy Levels, and Transitions
- 53.3 Nuclear Reactions and Scattering—of Photons
- 53.4 ——of Leptons, Mesons, and Hyperons
- 53.5 ——of Protons
- 53.6 ——of Neutrons
- 53.7 ——of Deuterons and Tritons
- 53.8 ——of $He^3$ and $He^4(\alpha)$
- 53.9 ——of Heavy Nuclei

54 Nuclei with $20 \leqslant A \leqslant 89$
- 54.1 Properties; Mass, Abundance, Moments, and Spin (see also 11.4 and 21.4)
- 54.2 Spectroscopy; Decay, Energy Levels, and Transitions
- 54.3 Nuclear Reactions and Scattering—of Photons
- 54.4 ——of Leptons, Mesons, and Hyperons
- 54.5 ——of Protons
- 54.6 ——of Neutrons
- 54.7 ——of Deuterons and Tritons
- 54.8 ——of $He^3$ and $He^4(\alpha)$
- 54.9 ——of Heavy Nuclei

55 Nuclei with $90 \leqslant A$
- 55.1 Properties; Mass, Abundance, Moments, and Spin (see also 11.4 and 21.4)
- 55.2 Spectroscopy; Decay, Energy Levels, and Transitions
- 55.3 Nuclear Reactions and Scattering—of Photons
- 55.4 ——of Leptons, Mesons, and Hyperons
- 55.5 ——of Protons
- 55.6 ——of Neutrons
- 55.7 ——of Deuterons and Tritons
- 55.8 ——of $He^3$ and $He^4(\alpha)$
- 55.9 ——of Heavy Nuclei

56 Nuclear Fission

**60 Elementary Particles and Fields**

61 Extraterrestrial Physics; Gravitation
- 61.2 Cosmic Rays (see also 61.4)
- 61.4 Astrophysics (see also 61.2 and 61.6)
- 61.6 Gravitation and General Relativity

62 Classical Physics and Quantum Theory
- 62.2 Mechanics and Acoustics; Special Relativity (see also 45.1)
- 62.4 Electromagnetism and Optics (see also 23, 44.4, and 62.8)
- 62.6 General Quantum Mechanics (see also 62.8)
- 62.8 Quantum Electrodynamics and Other Field Theories (see also 62.4, 62.6, and 64.4)

63 Interactions and Properties (Experiment) (see also 61.2)
- 63.2 Weak
- 63.4 Electromagnetic
- 63.6 Strong——Induced by Baryons (see also 52.6)
- 63.8 Strong——Induced by Mesons (see also 52.5)

64 Interactions and Properties (Theory)
- 64.2 Weak
- 64.4 Electromagnetic
- 64.6 Strong (General)
- 64.7 Strong (Baryon No. = 0)
- 64.8 Strong (Baryon No. = 1)
- 64.9 Strong (Baryon No. $\geqslant$ 2) (see also 51.6)

65 Scattering Theory (see also 51.6)
- 65.5 Asymptotic Behavior with Energy

66 Symmetries and Invariance Principles
- 66.2 Applications to Weak and Electromagnetic Interactions
- 66.4 Applications to Strong Interactions

**70 Errata**


## Subject Division of The Physical Review

EACH monthly volume of The Physical Review consists of five text issues and one index issue. Each text issue is devoted to a specific subject matter as follows (the capitalized word is a short title):

(1) ATOMS: Atoms; Molecules; Fluids; Plasmas. [Index categories 10, 30]
(2) SOLIDS I: Atoms, Ions, Nuclei, etc. in Matter; Collective Effects in Solids; Magnetic Materials; Ferroelectrics. [20, 41, 49]
(3) SOLIDS II: Solid-State Physics not in No. 2. [42–48]
(4) NUCLEI: Nuclear Structure, Properties, Reactions, and Scattering. [50]
(5) PARTICLES: Elementary Particles; Fields; Relativity. [60]

## Alphabetical Subject Index

For identification of code numbers, see the preceding Analytic Subject Index. Note that a reference to a major group (e.g., 40) is to be construed as a reference to all subjects in the group (41–49); a reference to an integral number (e.g., 41) is to be construed to include its decimal subgroups (41.1, 41.2, etc.); a reference of the form 5(2–5).1 is to be construed as 52.1, 53.1, 54.1, and 55.1.


| | |
|---|---|
| Acoustics | 45.1, 62.2 |
| Adsorption | 32.2, 42.2 |
| Alloys | 43.5, 46.3, 49.3 |
| Amorphous Solids | 42, 48.3 |
| Antiferroelectric Phenomena | 49.8 |
| Antiferromagnetism | 41.3, 49 |
| Antiferromagnetic Resonance | 49.7 |
| Astrophysics | 61 |
| Atmospheric Physics | 36 |
| Atomic Beams | 13, 14 |
| Atomic Mass and Abundance | 5(2–5).1 |
| Atomic Structure and Spectra | 11 |
| Atomic Structure Theory | 11.2 |
| Auger Effect | 11 |
| Band Structure | 44.1, 4(6–9).4 |
| Beta Decay | 51.6, 5(2–5).2 |
| Bosons, Elementary | 60 |
| Bosons in Fluids | 31, 34 |
| Bremsstrahlung | 14, 62.8 |
| Brownian Motion | 33.5 |
| Čerenkov Effect | 27, 62.4 |
| Chemical Effects | 12.5 |
| Classical Mechanics | 62.2 |
| Cold Emission | 26 |
| Collective Effects in Solids | 41, 4(6–9).1 |
| Collective Model of Nuclei | 51.2, 51.4 |
| Collision Processes (see also Scattering) | 13 |
| Colloids | 12.5 |
| Color Centers | 48.7 |
| Compton Effect | 11.6, 62.8 |
| Conduction, Electrical | 45.3, 4(6–9).5 |
| Conduction, Thermal | 45.2, 4(6–9).5 |
| Constants | 62 |
| Cosmic Radiation | 61.2, 61.4 |
| Cosmology | 61.4, 61.6 |
| Coulomb Excitation | 53, 54, 55 |
| Critical Phenomena | 33, 41.2, 4(6–9).1 |
| Cryogenics | 33, 34, 41.4, 41.5 |
| Crystal Fields | 22, 44 |
| Crystal Structure and Symmetries | 42.1 |
| Crystalline State | 40 |
| Cyclotron Resonance | 45.4, 4(6–9).5 |
| Defects | 43.1, 4(6–9).3 |
| de Haas–van Alphen Effect | 44.1, 46.4, 49.4 |
| Diamagnetism | 44.2, 4(6–9).4 |
| Dielectrics and Dielectric Properties | 44.2, 4(7–9).4, 49.8 |
| Diffraction, Electron | 13.4, 42.1 |
| Diffraction, Neutron | 32.4, 42.1, 49 |
| Diffraction, Optical and Microwave | 42.1, 62.4 |
| Diffraction, X-Ray | 42.1 |
| Diffusion | 33.5, 43.4 |
| Dislocations | 43.1 |
| Dispersion, Optical | 44.4, 62.4 |
| Dispersion Relations | 65 |
| Dissociation of Molecules | 12, 13 |
| Dynamics | 62.2 |
| Elasticity and Plasticity | 42.4, 4(6–9).2 |
| Elasto-Optic Effect | 44.4, 4(6–9).4 |
| Electrets | 49.8 |
| Electric Breakdown in Fluids | 35.5 |
| Electric Breakdown in Solids | 44.2 |
| Electrical Conductivity | 45.3, 4(6–9).5 |
| Electrical Discharges | 26, 35.5 |
| Electrical Properties of Solids | 44.2, 45.3 |
| Electrical Resistance | 45.3, 4(6–9).5 |
| Electrodynamics | 62.4, 62.8 |
| Electroluminescence | 44.3, 4(7–9).4 |
| Electromagnetic Interactions | 62.8, 63.4, 64.4, 66.2 |
| Electromagnetic Theory | 62.4 |
| Electromagnetic Waves | 23, 44.4, 62.4 |
| Electromagnetism | 62.4 |
| Electron Correlations in Solids | 41.1, 4(6–9).1 |
| Electron Diffraction | 13.4, 42.1 |
| Electron Emission | 26 |
| Electron Gas | 31, 35, 41.1, 46.1 |
| Electron Optics | 62.4 |
| Electron Spin Resonance | 14, 21.2, 4(6–9).6 |
| Electron States | 32.4, 44.1, 4(6–9).4 |
| Electronic Properties of Solids | 44, 4(6–9).4 |
| Electro-Optical Effects | 44.4, 4(6–9).4 |
| Electrostriction | 44.2, 4(6–9).4 |
| Elementary-Particle Interactions | 63, 64, 65 |
| Elementary-Particle Symmetries | 66 |
| Emulsions | 27 |
| Emissivity | 26, 44.3 |
| Energy Loss of Particles | 27 |
| Energy States of Atoms | 11 |
| Energy States of Molecules | 12 |
| Energy States of Nuclei | 51, 5(2–5).2 |
| Entropy | 33 |
| Equations of State | 33 |
| Errata | 70 |
| Evaporation | 32 |
| Excitation of Atoms | 11, 13, 14 |
| Excitation of Molecules | 12, 13, 14 |
| Excitation of Nuclei | 50 |
| Excitons | 44.3 |
| *F* Centers | 48.7 |
| Faraday Effect | 44.4, 4(7–9).4 |
| Fermi Surface | 44.1, 46.4, 47.4 |
| Fermions, Elementary | 51.4, 60 |
| Fermions in Matter | 31, 41.1, 4(6–9).1 |
| Ferrimagnetic Resonance | 49.7 |
| Ferrimagnetism | 49 |
| Ferrites | 49 |
| Ferroelectric Phenomena | 49.8 |
| Ferromagnetic Resonance | 49.7 |
| Ferromagnetism | 41.3, 49 |
| Field Emission | 26 |
| Field Theory | 61.6, 62.4, 62.8 |
| Films, Properties | 42.2 |
| Fine Structure | 11.4 |
| Fission, Nuclear | 56 |
| Fluctuation Phenomena | 33.5 |
| Fluid Dynamics | 30 |
| Fluids, Theory of | 31, 32 |
| Fluorescence | 44.3, 4(7–9).4 |
| Fusion, Nuclear | 35, 52 |
| Galvanomagnetic Effect | 45.4 |
| Gas Discharges | 35.5 |
| Gases | 32.2 |
| Geophysics | 36, 61 |

Glasses 42, 48.3
Gravitation 61.6
Gyromagnetization 21.4
Hall Effect 45.4, 46.5, 47.5, 49.5
Heat Capacity 33, 42.4
Heat Conduction 33.5, 45.2, 4(6–9).5
Heat of Dissociation and Formation 12, 33
Heat of Fusion 32, 33, 42.4
Heat of Vaporization 32, 33, 42.4
Heavy Nuclei, Scattering and Reactions 5(3–5).9
Helium, Liquid and Solid 34
Hydrodynamics 32
Hyperfine Structure 11.4, 22, 5(2–5).1
Hyperfragments 52.5, 53.4, 60
Hyperons 52.5, 5(3–5).4, 60
Hysteresis 49
Imperfections in Solids 43
Impurities in Solids 43.3
Insulators 48, 49
Interfaces 42.2
Internal Conversion 5(2–5).2
Internal Friction 43.1
Interstitials 43.3, 4(6–9).3
Ion Emission 26
Ionic Collisions 13.2
Ionization 13, 26, 35.5
Ionosphere 36
Ions 13, 22, 35
Ions and Electrons, Mobility 13, 43.4
Ions in Solids 22, 27
Irreversible Processes 33.5, 45
Isobars, Nucleonic 63.6, 63.8, 64.6
Isomers, Molecular 12
Isomers, Nuclear 5(2–5).2
Junctions 42.2, 47.5
Kinetic Theory of Gases 32.2, 33
Lasers 23, 44.4
Lattice Dynamics 42.3, 4(6–9).2
Liquid Helium 34
Liquids 32.4
Long-Range Order 41.3, 41.4, 49.8
Low-Temperature Phenomena 34, 41.4, 41.5
Luminescence 44.3, 4(7–9).4
Magnetic Breakdown 44.2
Magnetic Fields 62.4
Magnetic Materials 49
Magnetic Moments 14, 5(2–5).1
Magnetic Properties 44.2, 49, 4(6–9).4
Magnetic Resonance 14, 21, 4(6–9).6, 49.7
Magnetoacoustic Effects 45.1, 46.5, 49.5
Magnetoelectric Properties 45.4, 4(6–9).5
Magnetohydrodynamics 35
Magnetomechanical Effects 42.4, 44.2, 4(6–9).4
Magneto-Optical Effects 44.4, 4(6–9).4
Magnetoresistance 45.4, 4(6–9).5
Magnetostriction 42.4, 49.4
Magnetothermal Effects 42.4, 44.2, 4(6–9).2
Magnetotransport Effects 45.4, 4(6–9).5
Magnons 49
Many-Body Theory 31, 34, 41.4
Many-Body Theory of Nuclei 51.2, 51.4
Masers 23, 44.4
Mass Defects 5(2–5).1
Mass Spectroscopy 5(2–5).1
Mechanics 62.2
Mechanical Properties of Solids 42.4, 4(6–9).2
Mesonic Atoms and Molecules 15
Metals 46, 49
Metastable Atoms 11
Metastable Molecules 12
Microwaves 23, 62.4
Mobility of Ions and Electrons 13, 43.4, 45.3
Molecular Aggregates 12.5
Molecular Beams 13, 14
Molecular Structure and Spectra 12
Moments, Molecular 12, 14
Moments, Nuclear 21, 5(2–5).1
Mössbauer Effect 24
Muonium 15
Neutrinos 63.2, 64.2
Neutron Diffraction 32.4, 42.1, 49
Noise 33.5
Nuclear Abundance 5(2–5).1
Nuclear Decay 5(2–5).2
Nuclear Energy Levels 5(2–5).2
Nuclear Fission 56
Nuclear Forces 51
Nuclear Fusion 35, 52
Nuclear Isomers 5(2–5).2
Nuclear Magnetic Resonance 14, 21.4, 4(6–9).6
Nuclear Matter 51.4
Nuclear Moments and Spin 5(2–5).1
Nuclear Photoeffects 5(2–5).3
Nuclear Properties 5(2–5).1
Nuclear Quadrupole Resonance 14, 21.4, 4(6–9).6
Nuclear Reactions (see also Scattering) 50
Nuclear Relaxation 21.4, 4(6–9).6
Nuclear Spallation 50
Nuclear Spectra 5(2–5).2
Nuclear Spectra in Solids 21.4, 24, 4(6–9).6
Nuclear Structure Theory 51
Nuclear Transitions 5(2–5).2
Optical Masers 23, 44.4
Optical Model of Nuclei 51.2, 51.6
Optical Propagation in Solids 44.4, 4(6–9).4
Optical Properties of Solids 44.4, 4(6–9).4
Optics 62.4
Paramagnetic Resonance 21.2, 4(6–9).6
Paramagnetism 44.2, 4(6–9).4
Pair Production 60
Parity 5(2–5).2, 63, 64, 66
Particle Resonances 63–66
Phonons 42.3, 45.1
Phosphors and Phosphorescence 44.3, 4(7–9).4
Photoconductivity 45.3, 4(6–9).5
Photodisintegration 5(2–5).3
Photoelasticity 42.4, 4(6–9).2
Photoelectric Effect 11, 26, 45.3
Photomagnetic Effect 45.4, 4(6–9).5
Photomagnetoelectric Effect 45.3, 4(6–9).5
Photovoltaic Effect 45.3, 4(6–9).5
Piezoelectric Effect 45.3, 4(6–9).5
Plasmas 35, 41.1
Plasmons 41.1
Plasticity 42.4, 4(6–9).2
Polarization, Electrical and Magnetic 14, 44.2
Polarons 44.2, 44.4, 4(6–9).4
Polymers 12.5, 48.3
Positron Annihilation 15, 25, 63.4, 64.4
Positronium 15
Probability 33.5
Quadrupole Resonance 14, 21.4, 4(6–9).6
Quantum Electrodynamics 62.8, 64.4
Quantum Mechanics, General 62.6
Radiation Damage in Solids 43.2, 4(6–9).3
Radiative Processes in Atoms and Molecules 14
Radioactivity 5(2–5).2
Radio Astronomy 61.4
Raman Spectra 12

| | |
|---|---|
| Random Processes | 33.5 |
| Range and Energy Loss | 27 |
| Recoilless Absorption and Emission | 24 |
| Recombination | 13 |
| Regge Poles | 64.6, 65 |
| Relativity, General | 61.6 |
| Relativity, Special | 62.2 |
| Relaxation Processes | 14, 21, 33.5, 49.7 |
| Resistance, Electrical | 45.3, 4(6–9).5 |
| Resonance, Magnetic | 14, 21, 4(6–9).6, 49.7 |
| *S*-Matrix Theory | 64, 65 |
| Scattering of Atoms and Molecules | 13 |
| Scattering of Hyperons | 52.5, 5(3–5).4 |
| Scattering of Ions | 13.2 |
| Scattering of Leptons | 5(2–5).4, 63.4, 64.4 |
| Scattering of Mesons | 52.5, 5(3–5).4, 63.8, 64 |
| Scattering of Nucleons | 5(2–5).6, 5(3–5).5, 63.6, 64 |
| Scattering of Photons | 11.6, 5(2–5).3, 62.8, 63.4, 64.4 |
| Scattering Theory | 65 |
| Scintillation Counters | 27, 44.3 |
| Secondary Emission | 26 |
| Semiconductors | 47 |
| Semimetals | 46, 46.7 |
| Shell Model of Nuclei | 51.2 |
| Shock Waves | 32 |
| Solar Phenomena | 61.4 |
| Solid Helium | 34 |
| Sound | 45.1, 62.2 |
| Spallation | 50 |
| Spark Discharge | 26, 35.5 |
| Specific Heat | 33, 42.4, 4(6–9).2 |
| Spectra of Atoms and Molecules | 11, 12 |
| Spectra of Ions in Solids | 22 |
| Spectra of Nuclei | 5(2–5).2 |
| Spin, Nuclear | 5(2–5).1 |
| Spin Waves | 41.3, 49.7 |
| Spinor Fields | 62.8 |
| Sputtering | 13.2, 26 |
| Stark Effect | 11 |
| Statistical Mechanics | 33 |
| Statistical Methods | 33 |
| Stellar Phenomena | 61.4 |
| Stimulated Emission | 23, 44.3 |
| Stochastic Processes | 33.5 |
| Strong Interactions | 50, 63.6, 64.6–9, 66.4 |
| Superconductivity | 41.4, 41.5 |
| Superfluidity | 34 |
| Supersonics | 32, 62.2 |
| Surfaces | 42.2 |
| Susceptibility | 14, 44.2, 4(6–9).4 |
| Symmetries of Crystals | 42.1 |
| Symmetries of Elementary Particles | 66 |
| Thermal Conduction | 45.2, 4(6–9).5 |
| Thermal Diffusion | 33.5, 43.4 |
| Thermal Expansion | 33, 42.4 |
| Thermionic Emission | 26 |
| Thermodynamics | 33 |
| Thermoelectric Effect | 45.3, 4(6–9).5 |
| Thermoluminescence | 44.3, 4(6–9).4 |
| Thermomagnetic Effect | 45.4, 4(6–9).5 |
| Thermonuclear Reactions | 35, 52 |
| Thin Films | 42.2 |
| Transport Phenomena | 33.5, 45, 4(6–9).5 |
| Turbulence | 30 |
| Ultrasonics | 32, 45.1, 46.5, 62.2 |
| Vacancies | 43.1, 4(6–9).3 |
| Van der Waals Forces | 12, 32 |
| Viscosity | 30 |
| Weak Interactions | 63.2, 64.2, 66.2 |
| X Rays | 11.6, 42.1 |
| Zeeman Effect | 11, 12 |


## Announcement: Comments and Addenda

A new section, "Comments and Addenda," has been established in *The Physical Review* to meet a long-standing need for a place to publish short communications which are not of such urgency as to justify publication in *Physical Review Letters* and are not appropriate for regular articles. This section includes only the following types of communications:

1. Comments on papers previously published in *The Physical Review* or *Physical Review Letters*. Comments by others than the authors of the work being discussed will normally be sent to the latter to solicit their opinion, and to give them the opportunity (if the situation warrants it) of submitting a comment in reply for simultaneous publication.

2. Addenda to papers previously published in *The Physical Review* or *Physical Review Letters*, in which the additional information can be presented without the need for writing a complete article.

It should be noted that this new section is not intended as a medium for polemics, nor as a haven for poorly written short communications which would be more understandable and useful if written up in the normal format of a short article.

Manuscripts intended for this section may be accompanied by a brief abstract for information retrieval purposes. Accepted manuscripts will follow the same publication schedule as articles in this journal, and galleys will be sent to authors.

## ANNOUNCEMENT

### Increased Page Charges for the Physical Review

Sharply rising costs have made it necessary for the Council of the American Physical Society to raise the publication charge for papers published in *The Physical Review* from $60 to $75 per printed page. (This is the first such increase since January 1964.) The increased charge will take effect with the issues published in June 1969.

As before, an additional charge of $10 will be requested for publication of the abstract in *Physical Review Letters* and *Physics Abstracts.*

The publication charge for *Physical Review Letters* will remain at $60 per printed page, plus $10 per Letter for supporting abstracting and indexing services.

# Volume 176 Abstracts

SECOND SERIES, VOL. 176, NO. 1 DECEMBER 1968

*The abstracts of this volume are presented in order of increasing page number. The index numbers to the left of each byline refer to the categories listed in the Analytic Subject Index at the beginning of this Index Issue. In quoting information obtained from these abstracts, reference should be made to the page number of the article (given at the right of each byline), not to the page number in the present Index Issue.*

## Measurements of $L_2$- and $L_3$-Subshell Fluorescence Yields in Heavy Elements*

Richard E. Price† and Hans Mark
*Department of Nuclear Engineering, University of California, Berkeley, California*
and
C. D. Swift
*Lawrence Radiation Laboratory, University of California, Livermore, California*
11.6
54.2
(Received 22 May 1968)
p. 3

Measurements have been made of $L_2$- and $L_3$-subshell x-ray fluorescence yields, $\omega_2$ and $\omega_3$, for elements $Z=71$–83, 90, and 92. The method consisted of photoexciting $K$-shell vacancies in thin metal or oxide samples; observing with a Ge(Li) spectrometer the $K\alpha_1$ and $K\alpha_2$ x rays emitted as the $K$ vacancies were filled by electrons from $L_3$ or $L_2$ subshells; and counting, with a detector of calculated efficiency, the $L$ x rays (unresolved) which signify radiative filling of those vacancies. The directly measured quantities were $\omega_3$ and $\nu_2=\omega_2+f_{23}\omega_3$. The quantity $f_{23}$ was taken as $0.13\pm0.13$ to estimate $\omega_2$. The estimated precision (2 standard deviations) varies between 8 and 15%. The $\nu_2$ data agree with previous work. The $\omega_2$ values lie above most previous results. The $\omega_3$ values substantiate other recent experimental work, but exceed earlier estimates. The yields increase monotonically with increasing atomic number, within the limit of precision. Results with an alternative experimental arrangement indicate a small angular correlation in $K$-$L_3$-$M,N$ x-ray cascades.

## Theoretical Analysis of the Hyperfine Structure of Alkali Atoms*

L. Tterlikkis,† S. D. Mahanti,‡ and T. P. Das
*Department of Physics, University of California, Riverside, California*
11.2
(Received 27 May 1968)
p. 10

The hyperfine interaction in the alkali-atom series has been investigated quantitatively. In particular, both core-polarization and relativistic effects have been taken into consideration explicitly. The former effect was studied using the moment-perturbation procedure while relativistic Hartree-Fock theory was used for the latter. The core polarization contribution was found to be nearly constant for all the alkali atoms at about 23% of the nonrelativistic restricted Hartree-Fock value. Relativistic corrections were found to be 0.25, 0.68, 2.18, 15.6, and 20.5%, respectively, for lithium, sodium, potassium, rubidium, and cesium. The theoretical results are compared with experimental hyperfine constants to obtain an assessment of the importance of many-body effects in these atoms.

## Spin-Extended Wave Functions for First-Row Atoms*

Uzi Kaldor†
*Department of Chemistry, Stanford University, Stanford, California*
(Received 10 June 1968)
11.2
p. 19

An extension of Brillouin's theorem, stating that matrix elements of $H-EI$ between the spin-extended Hartree-Fock (SEHF) function and the projected singly-excited functions derived from it vanish, is used to calculate the SEHF function itself. Functions are reported for C, N, O, and F, using two basis sets for each atom. Results are compared with earlier calculations for other first-row atoms. Appreciable energy reductions with respect to the restricted Hartree-Fock results were obtained only for the closed-shell atoms He and Be, and a spin density in good agreement with experiment was obtained only for Li. It is suggested that larger basis sets may be required to span the SEHF functions.

## Hyperfine Structure of $^{67}$Ga and $^{72}$Ga*

Vernon J. Ehlers,† Yurdanur Kabasakal,‡ Howard A. Shugart, and Orhan Tezer‡
*Lawrence Radiation Laboratory and Department of Physics, University of California, Berkeley, California*
(Received 11 April 1968)
11.4
54.1
p. 25

We have used the atomic-beam magnetic-resonance technique to measure the hyperfine-structure separations and the differential hyperfine-structure anomalies of 78-hour $^{67}$Ga and 14-hour $^{72}$Ga in the $^2P_{3/2}$ and $^2P_{1/2}$ electronic states. From the differential hyperfine-structure anomaly we have deduced the standard hyperfine-structure anomaly for the two $J$ states. We have also calculated the nuclear moments from the measured hyperfine-structure separations. Our results are, for $^{67}$Ga ($I=\frac{3}{2}$): $\Delta\nu(^2P_{1/2})=2457.727\,26(90)$ MHz, $a(^2P_{3/2})=175.097\,36(15)$ MHz, $b(^2P_{3/2})=71.957\,50(55)$ MHz, $^{67}\delta^{69}=2.51(13)\times10^{-5}$, $^{67}\Delta^{69}(^2P_{1/2})=5.0(1.4)\times10^{-6}$, $^{67}\Delta^{69}(^2P_{3/2})=-20.1(2.0)\times10^{-6}$, $\mu_I$(uncorr) $=+1.8454(3)\mu_N$, and $Q=+0.22$ b; and for $^{72}$Ga($I=3$): $\Delta\nu(^2P_{1/2})=-153.652\,66(53)$ MHz, $a(^2P_{3/2})=-6.256\,98(11)$ MHz, $b(^2P_{3/2})=193.673\,65(80)$ MHz, $^{71}\delta^{72}=2.12(18)\times10^{-4}$, $^{71}\Delta^{72}(^2P_{1/2})=4.2(1.2)\times10^{-5}$, $^{71}\Delta^{72}(^2P_{3/2})=-17.0(2.0)\times10^{-5}$, $\mu_I$ (uncorr) $=-0.131\,86(2)\mu_N$, $Q=+0.59$ b. The quoted values of the nuclear magnetic moments include a correction for the hyperfine-structure anomaly, but do not include the diamagnetic correction.

## Effect of an External Radiation on the Energy Levels of an Electron System*

B. L. Jones and M. Verschueren
*Department of Physics, Simon Fraser University, Burnaby, British Columbia, Canada*
(Received 8 July 1968)
11 p. 42

The effect of an external radiation on the energy levels of an electron system is treated by a Green's-function technique. The external radiation is treated classically and is assumed to be totally incoherent. Using the statistical properties of the external radiation, an averaged one-electron Green's function which describes the properties of the electron system is defined and evaluated. The formalism includes the vacuum radiation corrections to the electron system. Expressions for the energy shifts and linewidths induced by the external radiation are obtained.

## Atomic Hyperfine Structure. I. Polarization Wave Functions for the Ground States of B, C, N, O, and F†

Henry F. Schaefer III,* Richard A. Klemm, and Frank E. Harris‡
*Department of Chemistry, Stanford University, Stanford, California*
11.2
11.4
53.1
(Received 22 July 1968)
p. 49

In order to discuss atomic hyperfine-structure effects not exhibited by restricted Hartree-Fock wave functions, a "polarization wave function" is introduced. This wave function, designed to include core polarization, is defined to be that configuration-interaction function which includes the restricted Hartree-Fock function plus all symmetry-allowed configurations differing therefrom by one spatial orbital. Good approximations to polarization wave functions are reported here for the ground states of B, C, N, O, and F. The resulting magnetic hyperfine-structure parameters are in better agreement with experiment than in previous *ab initio* calculations, being subject to between 25 and 45% error in the spin-density contributions and to less than 2% error in the other terms. The value of $\langle r^{-3} \rangle$ is found to depend significantly upon the operator in which it appears, and this dependence causes us to conclude that spin densities for B and C cannot be deduced from available experimental data. Our calculations are also used to provide improved values for the nuclear magnetic-dipole moment of $C^{11}$ ($\pm 0.997\ \mu_N$) and for the nuclear electric-quadrupole moments of $B^{10}$ (0.0804 b), $B^{11}$ (0.0386 b), $C^{11}$ ($\pm 0.0322$ b), and $O^{17}$ ($-0.0256$ b).

## *Ab Initio* Calculation of Screening Effects on $|\psi(0)|^2$ for Heavy Atoms*

M. Wilson†
*Physics Department, The Johns Hopkins University, Baltimore, Maryland*
(Received 3 June 1968)
11.2 p. 58

Hartree-Fock calculations are used to investigate screening effects on the values of $|\psi(0)|^2$ for heavy atoms. It is shown that such calculations represent reasonably well the actual screening behavior derived from observed isotope (and isomer) shifts. In addition to the already known importance of $5p$ and $5d$ electron screening effects, it is found, in the case of the actinides, that $5f$ screening effects are also important.

## Calculation of the $^1S$ State of the Beryllium Atom in Hylleraas Coordinates*

R. F. Gentner
*Department of Physics, Adelphi University,† Garden City, New York, and Department of Chemistry, St. John's University, Jamaica, New York*
and
E. A. Burke
*Department of Physics, Adelphi University,† Garden City, New York, and Department of Physics, Brookhaven National Laboratory,‡ Upton, New York*
11.2 (Received 9 May 1968) p. 63

The $^1S$ state of the Be atom is calculated in Hylleraas coordinates using a 25-term single-determinant wave function having the proper spin-angular-momentum symmetry. A ground-state energy of $-29.3158$ Ry is obtained, as compared with the experimentally observed value of $-29.337$ Ry and the best Hartree-Fock value of $-29.14596$ Ry, indicating that the application of the procedure to larger systems should be fruitful. Suggestions are given to improve the accuracy of the present method and to extend it to atoms of higher atomic number. Solutions of the integrals and procedures for manipulating them in storage are presented.

## Spin-Extended Wave Function for Atomic Sodium*

Uzi Kaldor†
*Department of Chemistry, Stanford University, Stanford, California*
(Received 29 July 1968)
11.2 p. 71

The spin-extended Hartree-Fock (SEHF) function, obtained by projecting the appropriate spin component of a UHF determinant with subsequent optimization, is calculated for $Na(^2S)$ with four different basis sets. Energy reductions relative to RHF values are small. Spin density at the nucleus is 12% off experimental value and rather insensitive to changes in basis set. It is tentatively concluded that SEHF spin density values are much more reliable for atoms with open $s$ shells than for those having open $p$ shells.

## Properties of the Lithium Sequence

A. Dalgarno
*Harvard College Observatory and Smithsonian Astrophysical Observatory, Cambridge, Massachusetts*
and
E. M. Parkinson
*Graduate School, Princeton University, Princeton, New Jersey*
11.2
14
(Received 31 May 1968)
p. 73

It is shown that in a perturbation description based upon a zero-order single-particle Hamiltonian, the diagonal and off-diagonal matrix elements of a single-particle operator for an $N$-particle system are essentially just linear combinations of matrix elements for

$|\psi(0)|^2$ for heavy atoms. It is shown that such calculations represent reasonably well the actual screening behavior derived from observed isotope (and isomer) shifts. In addition

Hamiltonian, the diagonal and off-diagonal matrix elements of a single-particle operator for an $N$-particle system are essentially just linear combinations of matrix elements for



two-particle systems. A similar statement applies to a restricted class of two-particle operators. The theory is applied to the calculation of the leading terms in the relativistic and mass-polarization corrections for the lithium sequence and to the calculation of the $2s-2p$ and $3s-3p$ dipole transition probabilities of the lithium sequence. Comparison of the transition probabilities with experimental data and with the results of refined variational calculations shows that high accuracy can be obtained.

## Doubly Excited States of $H^-$ of High Principal Quantum Number: Implications for Electron-Atom Ionization

A. Temkin, A. K. Bhatia, and E. Sullivan
*National Aeronautics and Space Administration, Goddard Space Flight Center, Laboratory for Theoretical Studies, Greenbelt, Maryland*
11.2
13.4
(Received 14 June 1968)
p. 80

It is pointed out that insight into the threshold region of electron-atom ionization can be gained by examination of the nature of the doubly excited states of the compound ion. A study of these states for $H^-$ has been initiated with two types of variational wave functions. One, $\Psi_W$, has the two electrons at roughly equal distances from the nucleus; the other, $\Psi_D$, has one electron at a very much farther distance so that it sees the dipole potential caused by the inner electron and the nucleus. Both functions are constructed to be eigenfunctions of the operator $Q_N$, which projects out all states of the target of principal quantum number less than $N$, and renders the energy subject to a minimum principle. If the number of states for which $\Psi_W$ yields a lower energy than $\Psi_D$ is proportional to $N^\gamma$, then an extrapolation argument shows that the threshold yield curve will be effectively proportional to $E^{(3-\gamma)/2}$. Calculations have been done to $N=5$ for $\Psi_D$ and $N=9$ for $\Psi_W$. Only the lowest of the $\Psi_W$ states is lower than the corresponding $\Psi_D$ state. The results suggest $\gamma$ in the range $0<\gamma\leq\frac{1}{2}$. Some comments on Wannier's theory of ionization are made.

## High-Order Perturbation Theory for a One-Electron Ion in a Uniform Electric Field*

Lawrence B. Mendelsohn
*Department of Physics, Polytechnic Institute of Brooklyn, Brooklyn, New York* 11201
(Received 17 July 1968)
11.2
p. 90

Large-$Z$ expansion theory is applied to the nonrelativistic ground state of a one-electron ion and the subsequent first-order differential equations are solved recursively. For each order of perturbation theory, a general expression for the wave function is found. The substitution of this form into the perturbation-theory equations reduces the problem for the $K$th-order wave function and energy to solving recursively a set of linear algebraic equations of approximately $2K$th order for the coefficients of certain radial polynomial terms appearing in the wave function. The asymptotic-series results for both the energy and the wave function are obtained explicitly through tenth order. For hydrogen a calculation of the ionization field (ignoring tunneling) gives a value of $3.36\times10^8$ V/cm. This agrees well with experimental results on field ionization and a recent accurate variational treatment and is found to be much superior to a WKB result.

## Angular Distribution of Molecular Photoelectrons*

John C. Tully,† R. Stephen Berry, and Bryan J. Dalton‡
*Department of Chemistry and The James Franck Institute, University of Chicago, Chicago, Illinois* 60637
(Received 16 May 1968)
14
p. 95

The nonrelativistic differential cross sections for photo-ionization of molecules are derived and are worked out in detail for systems with random orientation. The more important contributions due to electric dipole, electric quadrupole, magnetic dipole, and two-photon (nonresonant) absorption have been included. Processes such as vibrationally induced autoionization have been discussed. The significance of these results with regard to the design and interpretation of photo-ionization experiments is also considered. The angular distribution of photoelectrons from $H_2$ is calculated as an example.

## Magnetic Hyperfine Structure and Core Polarization in the Excited States of Lithium*

William A. Goddard, III†
*Alfred A. Noyes Laboratory of Chemical Physics,‡ California Institute of Technology, Pasadena, California* 91109
(Received 25 June 1968)
11.2
11.4
p. 106

The magnetic hyperfine splitting constants, $a_J$, from theoretical calculations on the $3^2S$, $2^2P$, $3^2P$, and $3^2D$ excited states of the Li atom are reported. The wave functions were calculated using the author's GF method, which corresponds to optimizing the orbitals of a Slater determinant *after* spin projection. Thus the wave functions include core polarization, but no appreciable correlation. For the $2^2P$ state we calculate $a_{1/2}=0.2206$ a.u. (45.74 Mc sec for $^7$Li) which is in good agreement with the experimental value, $0.2227\pm0.0017$ a.u. ($46.17\pm0.35$ Mc/sec for $^7$Li), and the value from configuration interaction calculations, 0.2206. Thus for the Li atom core polarization accounts for most of the error in the Hartree-Fock values of $a_J$. These calculations yield $\langle 1/r^3\rangle$ and spin density, $Q(0)$, in agreement with other accurate theoretical calculations, and in disagreement with the values found using level crossing experiments, indicating that the interpretation of the level crossing experiments in terms of $\langle 1/r^3\rangle$ and $Q(0)$ may not be correct. It is found that for both the unrestricted Hartree-Fock and GF methods the use of a different Hamiltonian for each electron leads to virtual orbitals which are good approximations to the actual orbitals of excited states.

## Relativistic Calculations of Electron Binding Energies by a Modified Hartree-Fock-Slater Method

Arne Rosén and Ingvar Lindgren
*Department of Physics, Chalmers University of Technology, Göteborg, Sweden*
(Received 8 July 1968)
11.2
p. 114

Relativistic atomic wave functions and electron binding energies have been calculated by a modified Hartree-Fock-Slater method. The local exchange approximation, originally introduced by Slater, is modified in such a way that the total energy of the system is minimized

Approximate expressions for the optimum exchange potential are suggested for all atoms and ions. The total atomic energies and electron binding energies obtained by this method agree extremely well with the corresponding Hartree-Fock results in the cases where such data are available. Various corrections to the theoretical binding energies are discussed, in particular the effect of rearrangement during the ionization process. It is found that this effect is of importance for inner shells in all elements and is responsible for the main discrepancy between experimental and previous theoretical results for light and medium-heavy elements. For heavy elements other effects are of importance, and various possible sources of the residual discrepancy between theory and experiments are discussed.

## Photo-Ionization of Lithium: A Many-Body Calculation

Edward S. Chang* and M. R. C. McDowell*†
*Laboratory for Theoretical Studies, Goddard Space Flight Center, National Aeronautics and Space Administration, Greenbelt, Maryland*
(Received 21 June 1968)

14 p. 126

The photo-ionization cross section $a_\nu$ of lithium has been calculated to second order in Brueckner-Goldstone perturbation theory with Hartree-Fock as zero order, for ejected electron energies in the range $0 \leq k^2 \leq 0.36$ Ry. Other Hartree-Fock calculations of $a_\nu$ are analyzed using certain new theorems relating alternative forms of the matrix element. The final second-order perturbed values of $a_\nu$ in the length and velocity formulations are in good agreement with experiment throughout the energy range studied.

## Measurements of the Electron Impact Excitation Cross Section of $N_2^+$ First Negative Bands*

B. N. Srivastava and I. M. Mirza†
*Geophysical Institute, University of Alaska, College, Alaska*
12
13.4 (Received 12 July 1968) p. 137

Emission cross sections for the $N_2^+$ first negative bands produced by electron impact on $N_2$ have been measured using a photon counting technique in the energy range 70 eV to 4 keV. The maximum cross section for the $v'=0$ vibrational level of the $B\,^2\Sigma_u^+$ excited state of $N_2^+$ is $2.38 \times 10^{-17}$ cm$^2$. The ratio of cross sections for the (0, 0), (0, 1) and (0, 2) bands of first negative system is 1: 0.34: 0.065. The total emission cross section for the $v'=0$ vibrational level accounts for 10% of the total ionization cross section of $N_2$.

## Theory of Electronic Transitions in Slow Atomic Collisions†

Jean Heinrichs*
*Department of Physics, University of California, San Diego, La Jolla, California*
(Received 29 May 1968)

13 p. 141

The near-adiabatic transition probability between a pair of pseudocrossing adiabatic (molecular) electronic states is studied be generalizing Zener's time-dependent treatment and describing the heavy-particle motion classically. This more rigorous formalism, based however on the simple Landau-Zener model, leads to the well-known Landau-Zener formula in a first approximation. From a reasonable definition of the width of the finite region over which the transitions take place on the trajectory, a precise condition which inherently limits the validity of the formula is derived. This condition may be compared with similar ones obtained in recent quite different derivations and removes some apparent difficulties which have been raised in connection with earlier treatments. The first correction to the Landau-Zener formula, associated with the finiteness of the transition region, is studied analytically and found to be important and to have interesting properties. This leads to further information about the validity of the simple Landau-Zener expression.

## Contribution of Perturber Radiation to the Shapes of Spectral Lines Broadened by Electron Impacts

D. D. Burgess*
*Harvard College Observatory, Cambridge, Massachusetts, and Physics Department, Imperial College of Science and Technology, London, England*
13.4 (Received 12 July 1968)
14
35 p. 150

**Theories of electron-impact broadening have previously neglected the radiation produced by the perturbing electrons. In this paper a theory is developed to take the perturber radiation into account, and so to evaluate possible interference terms. These may lead to observable asymmetries of lines of ionized emitters.**

## Formation of Ionized Excited States Through the Loss of the Metastable Electron in Noble-Gas Atoms*

S. H. Koozekanani
*Electroscience Laboratory, Department of Electrical Engineering, Ohio State University, Columbus, Ohio 43212*
(Received 26 June 1968)
13.4 p. 160

It is shown that when the metastable electron of a noble-gas atom is removed by a fast collision it is quite possible for the atom to be ionized and excited at the same time. Excitation cross sections for the processes

$$np^5(n+1)s \xrightarrow{-e} np^4\text{-}ml'' \quad \text{or} \quad np^5(n+1)s \xrightarrow{-e} np^4\text{-}ml''$$

have been calculated in terms of the cross sections for removing the electrons.

## Electron-Impact Ionization of H (2s) and H (2p)

H. Lee Kyle and K. Omidvar
*Laboratory for Theoretical Studies, Goddard Space Flight Center, Greenbelt, Maryland*
(Received 1 April 1968; revised manuscript received 28 August 1968)
13.4 p. 164

In the first part of the paper, cross sections for the electron-impact ionization of the 2s and the 2p, $m=0, \pm 1$ states of atomic hydrogen have been calculated, using two forms, B. E. (i) and B. E. (ii), of the Born–exchange approximation. For the form B. E. (i), it is found that

The near-adiabatic transition probability between a pair of pseudocrossing adiabatic (molecular) electronic states is studied be generalizing Zener's time-dependent treatment and describing the heavy-particle motion classically. This more rigorous formalism, based how-

In the first part of the paper, cross sections for the electron-impact ionization of [illegible] and the $2p$, $m = 0, \pm 1$ states of atomic hydrogen have been calculated, using two forms, B. E. (i) and B. E. (ii), of the Born-exchange approximation. For the form B. E. (i), it is found that



inclusion of exchange increases the cross section for the $2p(m = \pm 1) \rightarrow c$ transition, but decreases the cross sections for the $2s \rightarrow c$ and $2p(m = 0) \rightarrow c$ transitions. In the B. E. (ii) calculation, inclusion of exchange always decreases the cross sections. For the $2s \rightarrow c$ transition Prasad's Born-exchange calculations are verified. In the second part, the binary collision approximation of Vainshtein has been applied to the $2s$ and the $2p$ ionization, and it is found that the Vainshtein approximation with its proper choice of effective charge does not agree with the Born-exchange approximation. A new expression for the exchange amplitude has been derived in the Vainshtein approximation. We have concluded by comparing the results of the Born, the Born-exchange, the Born-Ochkur, and the Vainshtein's approximations for the ionization of the $1s$, $2s$, and the $2p$ states of atomic hydrogen.

## Spin Polarization of Low-Energy Electrons Scattered Elastically from Atoms and Molecules*

A. C. Yates†
*Department of Chemistry, Indiana University, Bloomington, Indiana* 47401
(Received 1 July 1968)
13.4 p. 173

The $Z$ dependence of total spin polarization is systematically ascertained by tracing the trajectory of a particular zero of the scattered amplitude as a function of atomic number. The incident electron energy corresponding to 100% polarization is shown to increase linearly with increasing atomic number. In addition, it is found that total polarization is confined to a relatively narrow angular range for varying $Z$. Further calculations on the independent-atom model representation of electron spin polarization for electron-molecule collisions are given. Arguments leading to the improbability of obtaining enhanced polarization over the atomic case are presented. The most significant result of these calculations is the relative insensitivity of the spin polarization to the molecular parameters.

## Rotational Excitation of Polar Molecules by Electrons

M. H. Mittleman and J. L. Peacher*
*Space Sciences Laboratory, University of California, Berkeley, California*
and
B. F. Rozsnyai†
*Biomedical Research Division, Lawrence Radiation Laboratory, Livermore, California*
12
(Received 19 July 1968)
13.4 p. 180

Rotational excitation of polar molecules is calculated in the approximation that the electron transit time is short compared with rotational periods with the result of an $E^{-1}$ behavior of the cross section. Diffusion cross sections are calculated for $\Delta l = 0, 1, 2$. Significant corrections to the Born approximation are obtained for large dipole moments. The range (in energy) of applicability of the result is discussed in terms of the energy dependence of the corrections, and a novel energy dependence of these corrections is encountered and explained.

## Theory of Polarization of Molecular Line Radiation Excited by Electron Impact*

A. Norman Jette
*Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Maryland*
and
Patrick Cahill†
*Columbia University Radiation Laboratory, New York, New York*
12
(Received 9 August 1968)
13.4
14 p. 186

The Percival-Seaton theory for the polarization of atomic impact radiation is extended to the case of diatomic molecules. Similar to the atomic case, it is shown that for excitation by electron impact involving a change of electronic angular momentum along the molecular internuclear axis, the threshold polarization can be determined from the symmetry of the total molecular wave function without a detailed knowledge of the inelastic cross sections. General expressions are developed for the cases of fine and hyperfine splitting, and explicit relations are given for the first two rotational levels of a $^3\Pi_u$ state undergoing a radiative transition to a $^3\Sigma_g$ state in the limit of fine and hyperfine separations being much larger than the natural linewidth. This theory is valid when the radiative state is populated by a direct interaction, and the radiative transition between rotational states is resolved.

## Nonadiabatic Long-Range Forces

A. Dalgarno
*Smithsonian Institution Astrophysical Observatory, and Harvard College Observatory, Cambridge, Massachusetts*
G. W. F. Drake*
*Smithsonian Institution Astrophysical Observatory, Cambridge, Massachusetts*
and
G. A. Victor
*Technology Division, GCA Corporation, Bedford, Massachusetts*
(Received 17 July 1968)
11.2
13 p. 194

A general expression is obtained for the leading long-range correction to the static interaction of a slowly moving charged or neutral system at a large distance from a spherically symmetric atom, and precise estimates are presented of the magnitude for the systems H, He ($1^1S$, $2^1S$, and $2^3S$), Ne, Ar, Kr, Xe, $Li^+$ ($1^1S$, $2^1S$, and $2^3S$), Li, Na, K, Rb, Cs, $H_2$, $N_2$, and $CH_4$.

## Relativistic Corrections to the Light-Scattering Spectrum of a Plasma*

O. Theimer
*New Mexico State University, Research Center, Las Cruces, New Mexico*

and

J. E. Sollid
*New Mexico State University, Physics Department, Las Cruces, New Mexico*
(Received 5 September 1967; revised manuscript received 22 July 1968)

35 p. 198

The light scattering spectrum of a plasma with drift-displaced Maxwellian velocity distribution is calculated to first order in $\vec{v}/c$ ($c$ = velocity of light). The scattered intensity is obtained from the nonrelativistic Vlasov equation, and from the Lienard-Wiechert potentials produced by electrons which move with velocity $\vec{v}$, and are accelerated by the incident electric and magnetic radiation fields. For the incoherent spectrum, the relativistic effects are found equivalent to an apparent drift-velocity component parallel to the scattering vector $(\vec{k}^s - \vec{k}^i)$ of approximate magnitude $(5/3)v_e(v_e/c)\sin\frac{1}{2}\theta$, where $v_e$ is the rms thermal electron velocity, $\theta$ the scattering angle, and $\vec{k}^s$ ($\vec{k}^i$) the wave vector of the scattered (incident) radiation. In the coherent spectrum the relativistic corrections are found proportional to the quantity $\omega/c\,|\vec{k}^s - \vec{k}^i|$. Because of the proportionality to the frequency shift $\omega$, the corrections are negligible for the ion spectrum.

## Angular Dependence of Scattering Products in Electron-Molecule Resonant Excitation and in Dissociative Attachment

Thomas F. O'Malley*
*General Research Corporation, Santa Barbara, California*

and

Howard S. Taylor†‡
*Department of Chemistry, University of Southern California, Los Angeles, California* 90007
12.5 (Received 25 April 1968)
13.4 p. 207

For the processes mentioned in the title, the general rearrangement formalism of a previous paper is applied with specific consideration to the effect of molecule orientation on the electronic matrix elements and on the total and differential cross sections. Formulas are given for two cases: when one can and when one cannot treat the effect of rotation as a semiclassical orientation average. A short discussion is given of selection rules and of the use of these formulas in (a) *ab initio* calculation of the cross section, (b) approximate prediction of angular dependence, and (c) parametrization of experimental data.

## Helium Drag in the Theory of Impurity Mobility in Liquid Helium*

M. Bailyn and R. Lobo†
*Physics Department, Northwestern University, Evanston, Illinois*
(Received 12 July 1968)

34 p. 222

A "helium-drag" effect is calculated for the mobility of charged impurities in $He^3$, and $He^3$-$He^4$ mixtures. For low enough temperatures, the momentum imparted by the impurities to the helium may be partly trapped in the impurity-helium system, thereby raising the conductivity. This effect gives rise to a term in the mobility proportional to the concentration of impurities, and varying as $T^{-2}$ for the lowest temperatures. It is estimated that the impurity concentration for this effect to be observed is easily within experimental reach for $He^3$-$He^4$ mixtures, and possibly even for pure $He^3$.

## Concentration-Dependent Polarization in $He^3$-$He^4$ Solutions*

L. J. Campbell
*Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico* 87544
(Received 10 June 1968)

34 p. 225

The nuclear spin polarization of dilute solutions of $He^3$ in superfluid $He^4$ in contact with a polarized pure $He^3$ bath is calculated for $He^3$ concentrations between zero and 6.37% for various values of the spin relaxation time and transfer rate of $He^3$ into solution.

## Linear Stark Broadening in High-Density Lithium Plasma

B. Ya'akobi*
*Department of Physics, The Hebrew University, Jerusalem, Israel*
14 (Received 29 May 1968)
35 p. 227

High-density plasma was produced by exploding lithium wires. At the average electron concentration obtained, $2.5\times10^{17}$ cm$^{-3}$, the measured Stark profile of the $2p$-$5d$ line is shown to be almost identical to that calculated for the $H_\gamma$ line of hydrogen at the same electron concentration. The transition from quadratic to linear Stark broadening is discussed.

## Formation of Nonlocalized Vacancies in bcc $He^3$ *

J. H. Hetherington
*Physics Department, Michigan State University, East Lansing, Michigan*
(Received 9 August 1968)

34 p. 231

Several experiments have indicated the formation of some defect in body-centered cubic solid $He^3$ at relatively low energies. A few alternative hypotheses are discussed which could explain this effect, but vacancy formation is singled out for study. The wave function and formation energy of vacancies in solid $He^3$ are then calculated variationally, and it is found that such a vacancy would be highly nonlocalized and would propagate as a wave in the crystal. The calculation of the energy of formation, actually an energy band, uses the Nosanow cluster expansion. The energy so calculated is compared with the experimental formation energies, and it has the correct dependence on density although it is higher than the experimental values.

He³-He⁴ mixtures. For low enough temperatures, the momentum imparted by the impurities to the helium may be partly trapped in the impurity-helium system, thereby raising the

Nosanow cluster expansion. The energy so calculated is compared with the experimental formation energies, and it has the correct dependence on density although it is higher than the experimental values.



## Unified Approximation for the Velocity Autocorrelation Function and the Structure Function of a Simple Liquid

Leon Glass* and Stuart A. Rice
*Department of Chemistry and The James Franck Institute, The University of Chicago, Chicago, Illinois* 60637

32.4 (Received 31 May 1968; revised manuscript received 26 August 1968)
33 p. 239

A theory of one-particle and two-particle motions in monatomic classical liquids, which employs the two-particle position-dependent Green's function in a fundamental way is developed. An equation of motion for the autocorrelation function is derived by assuming that a Brownian particle diffuses in a mean-time-dependent field. The motion of the atoms which generate the time-dependent field is described by the Green's function. In addition, the Green's function is directly related to the Van Hove scattering function in a simple way. The velocity autocorrelation function and neutron scattering cross sections are computed for liquid argon by assuming a relaxation approximation for the two-particle Green's function. Comparisons are made with recent experimental results.

## Crystalline Order in Two Dimensions*

N. D. Mermin†
*Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York*

33 (Received 1 July 1968)
42.1 p. 250

If $N$ classical particles in two dimensions interacting through a pair potential $\Phi(\vec{r})$ are in equilibrium in a parallelogram box, it is proved that every $\vec{k} \neq 0$ Fourier component of the density must vanish in the thermodynamic limit, provided that $\Phi(\vec{r}) - \lambda r^2 | \nabla^2 \Phi(\vec{r})|$ is integrable at $r = \infty$ and positive and nonintegrable at $r = 0$, both for $\lambda = 0$ and for some positive $\lambda$. This result excludes conventional crystalline long-range order in two dimensions for power-law potentials of the Lennard-Jones type, but is inconclusive for hard-core potentials. The corresponding analysis for the quantum case is outlined. Similar results hold in one dimension.

## Superfluid Phase Transitions in One and Two Dimensions

Allan Widom
*Northeastern University, Boston, Massachusetts*

32.4
33.5 (Received 6 June 1968)
34 p. 254

A recently proved theorem of statistical physics states that a one- or two-dimensional Bose liquid in homogeneous thermodynamic equilibrium cannot undergo Bose-Einstein condensation. The theorem does not apply to inhomogeneous liquids. This is shown by considering the ideal Bose liquid (i) in the presence of a gravitational field and (ii) in rotational motion. The existence of well-defined one- and two-dimensional phase transitions with Bose-Einstein condensation is proved by these explicit examples.

## Renormalization of Critical Exponents by Hidden Variables

Michael E. Fisher
*Baker Laboratory, Cornell University, Ithaca, New York*

41.2
46.1 (Received 19 April 1968)
49.1 p. 257

The thermodynamics of the critical point is discussed generally for a system in which some "hidden variable" $x$, e.g., a density of impurities, fluctuates in equilibrium but is subject to a constraint (e.g., fixed number of impurity atoms). Under rather general assumptions it is shown that the "ideal" critical exponents $\alpha$, $\alpha'$, $\beta$, $\gamma$, $\Delta$, ... governing the temperature variation at the critical point when $x \equiv 0$ become renormalized to the values $\alpha_X = -\alpha/(1-\alpha)$, $\beta_X = \beta/(1-\alpha')$, $\gamma_X = \gamma/(1-\alpha)$, $\Delta_X = \Delta/(1-\alpha)$, .... A variety of exactly soluble models are discussed, including a "mobile-electron Ising ferromagnet," for which this renormalization can be checked explicitly. The relevance of these results for the interpretation of theoretical and experimentally observed critical exponents is considered briefly.

## Nuclear Spin-Lattice Relaxation in Very Dilute Solutions of Orthohydrogen in Parahydrogen *

C. E. Miller†
*Cryogenics Division, Institute for Materials Research, National Bureau of Standards, Boulder, Colorado*
and
M. Lipsicas
*Brookhaven National Laboratory, Upton, New York, and Belfer Graduate School of Science, Yeshiva University, New York, New York*

21.4
32.4 (Received 29 July 1968)
p. 273

Measurements have been made of the proton spin-lattice relaxation time in very-dilute solutions of orthohydrogen in parahydrogen as a function of temperature, density, and fractional orthohydrogen concentration. Both the liquid phase, between 20 and 32 K, and the gas phase, between 34 and 40 K, have been studied. The salient features of the temperature and density dependences qualitatively fit an interpretation in terms of contributions from two-particle and three-particle correlations, as proposed by Deutch and Oppenheim.

## Shell Structure and the Thomas-Fermi Equation of State*

J. W. Zink
*Lawrence Radiation Laboratory, University of California, Livermore, California*

(Received 18 April 1968; revised manuscript received 9 October 1968)
11.2
33 p. 279

The calculation of the electronic contribution to the equation of state of high-temperature, high-density matter by means of Thomas-Fermi theory is modified to include the effect of shell structure. Shell structure is included by accounting for the discrete nature of the energy levels of the bound states. The free states are treated by means of Thomas-Fermi theory. Comparisons are made between Thomas-Fermi (TF) theory and Thomas-Fermi

shell (TFS) theory. The pressure and energy calculated by means of TFS theory vary about those calculated by means of TF theory, and for some temperatures and densities they are substantially different even at pressures far in excess of the 100-Mbar region where TF theory is generally thought to be applicable.

## Velocity of Sound at 1 MHz Near the $He^4$ Critical Point

R. C. Williamson
*Center for Materials Science and Engineering, Massachusetts Institute of Technology, and NASA Electronics Research Center, Cambridge, Massachusetts*

and

C. E. Chase
*Francis Bitter National Magnet Laboratory,* Massachusetts Institute of Technology, Cambridge, Massachusetts*

32
34
(Received 27 June 1968)
p. 285

The velocity of 1-MHz sound waves has been measured in $He^4$ along several isotherms just above the critical temperature. The results indicate that along the critical isotherm, the quantity $\rho/u^2$ diverges approximately logarithmically as a function of $|P-P_c|$. Such a singularity at the critical point is to be expected in view of the corresponding singularity in $C_v$. Additional velocity measurements were made in the saturated liquid, along isotherms several tenths of a degree above $T_c$, and along the 4.5 and 5.0°K isotherms in the liquid. The specific-heat ratio has been calculated along the latter two isotherms and along the critical isotherm.

## Some Remarks on Perturbation Theory and Critical Phenomena*

P. T. Herman and J. R. Dorfman
*Institute for Fluid Dynamics & Applied Mathematics, and Department of Physics & Astronomy, University of Maryland, College Park, Maryland*

33
41.2
(Received 23 May 1968)
p. 295

Thermodynamic perturbation theory is applied to systems that undergo a phase transition. It is shown that certain conditions are necessary in order that the application of the perturbation does not change the qualitative features of the phase transition, e.g., the critical indices. The method is then applied to the two-dimensional-square Ising lattice with nearest-and next-nearest-neighbor interactions. The shift in the critical temperature is determined to two orders in the perturbation parameter, viz., the ratio of the strength of the next-nearest-neighbor force to the strength of the nearest-neighbor force. A similar calculation is also made for a two-dimensional-lattice potential of Kac and Helfand.

## Generalized Scaling and the Critical Eigenvector in Ideal Bose Condensation

Martin J. Cooper* and Melville S. Green†
*National Bureau of Standards, Washington, D. C.*

33
41
(Received 1 May 1968)
p. 302

The condensation of an ideal Bose gas, in which the phase symmetry of the boson states has been removed by a linear coupling of the creation and annihilation operators $\psi^\dagger(\vec{r})$, $\psi(\vec{r})$ to a fictitious external field $C(\vec{r})$, is considered as a model of a second-order phase transition. In the vicinity of the transition, the spontaneous-order parameter (thermal expectation value of $\psi$) is related to the conjugate field by a series of terms of which the first represents a scaled equation of state that exhibits a power-law behavior with nonclassical exponents. The expectation value for the ordered product of boson operators $\langle\psi^\dagger(1)\,\psi^\dagger(2)\cdots\psi^\dagger(M)\,\psi(1')\cdots\psi(N')\rangle_\beta$ is determined and its behavior across the coexistence curve discussed. The existence of a conjectured critical eigenvector is demonstrated and a related asymptotic property of the ordered product determined.

## Conductivity of a Plasma in a Steady Magnetic Field. II

T. Pradhan and B. Dasgupta
*Saha Institute of Nuclear Physics, Calcutta, India*

33.5
35
(Received 9 July 1968)
p. 309

With the aid of techniques used in our previous paper I, we prove, without recourse to any approximation, that $k_\mu k_\nu \sigma_{\mu\nu}(\vec{k},\omega)/k^2$ is independent of the magnetic field strength.

## Crystalline Transformation of Helium Three

Louis Goldstein
*University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico* 87544

34
41.2
(Received 16 May 1968)
p. 311

The main thermal characteristics of the structural change at low temperatures of solid $He^3$, from the cubic to the hexagonal form, are expected to be governed by the dominant spin excitations. The spin-dependent interactions in these structures are assumed to be proportional to the scalar product of the nuclear spin vectors on nearest-neighbor atoms. With the currently available, if scarce, empirical interaction strengths, the transformation is probably anomalous. One aspect of the anomaly corresponds to the appearance of a very shallow minimum of the transformation pressure. It arises from the negative or anomalous latent heat of transformation at low temperatures, wherein heat has to be supplied to the low-density cubic solid to change it into the high-density close-packed solid, the transformation proceeding at constant temperature and pressure. At temperatures which are high compared to the very low spin-ordering temperatures of these structures, the anomaly is independent of the nature, ferromagnetic or antiferromagnetic, of the spin-ordering processes in the two solids along the transformation line. The increase in the anomalous-transformation pressure with decreasing temperature is estimated to become observable in the several-millidegree temperature range, the pressure anomaly increasing hyperbolically with decreasing temperatures.

mined to two orders in the perturbation parameter, viz., the ratio of the strength of the next-nearest-neighbor force to the strength of the nearest-neighbor force. A similar calculation is also made for a two-dimensional-lattice potential of Kac and Helfand.

decreasing temperature is estimated to become observable in the several-millidegree temperature range, the pressure anomaly increasing hyperbolically with decreasing temperatures.



On compressing solid $He^3$, the strength of the assumed nearest-neighbor spin-dependent atomic pair interactions, as well as the attendant spin-ordering temperatures, decrease very rapidly. As a result, within the limits of validity of the interaction model, both the cubic and, above all, the hexagonal solid exhibit practically ideal nuclear paramagnetism down to very low temperatures. The possibility of exploiting this ideal magnetic behavior of solid $He^3$ for the production and control, through static experiments, of very low temperatures is briefly discussed.

## Ultrasonic Attenuation in Liquid Metals. II.* Dense-Gas Formulation

K. C. Sharma†
*Theoretical Physics Institute, Department of Physics, University of Alberta, Edmonton, Canada*
32.4 33.5 (Received 4 June 1968) p. 319

Making use of Enskog's dense-gas formulation and the van der Waals concept of a dense fluid, we discuss the excess attenuation of ultrasonic waves in monatomic liquid metals at the melting point and as a function of temperature, in particular for mercury. The agreement with experiment is found to be satisfactory.

## Electron-Temperature Dependence of Electron-Ion Recombination in Argon*

F. J. Mehr and Manfred A. Biondi
*Physics Department, University of Pittsburgh, Pittsburgh, Pennsylvania*
13 35.5 (Received 22 May 1968) p. 322

A 3-mode microwave apparatus is used to study the dependence of the dissociative recombination coefficient $\alpha(Ar_2^+)$ on electron temperature $T_e$ over the range $300°K \leq T_e \leq 10\,000°K$ while the ion and gas temperatures remain at 300°K. A high-Q cavity mode is used to ionize the gas periodically, a second high-Q mode is used to determine the decay of electron density during the afterglow from the change of resonant frequency of the cavity, and a nonresonant waveguide mode is used to apply a constant microwave heating field to the electrons. At $T_e = 300°K$, a value $\alpha(Ar_2^+) = (8.5 \pm 0.8) \times 10^{-7}$ cm$^3$/sec is obtained from analysis of recombination-controlled electron-density decays using a computer solution of the electron continuity equation which includes recombination and ambipolar diffusion terms. Over the range $300°K \leq T_e \leq 10\,000°K$, the coefficient $\alpha(Ar_2^+)$ is found to follow a simple $T_e^{-0.67}$ variation. This result is reconciled with Fox and Hobson's $T^{-1.3}$ variation, obtained under conditions where $T_e = T_i = T$, on the basis of their changing $Ar_2^+$ vibrational-state populations with changing temperature. Finally, it is noted that our $T_e^{-0.67}$ variation may be evidence for appreciable electron capture via the *indirect* as well as the direct dissociative process.

## Radial Distribution Function for a Quantum Plasma

R. G. Storer
*School of Physical Sciences, The Flinders University of South Australia, Australia*
(Received 30 July 1968)
35 p. 326

The radial distribution function for a plasma is calculated for small interparticle separations. Quantum effects are taken into account by using either a modification of the path-integral technique or the equivalent sum-over-states expression under the assumption that the charged particles interact via a shielded Coulomb potential.

## Ion Energies at the Cathode for Conduction Through Rarefield Gases

D. R. Schoonover*†
*Physics Department, University of Missouri-Rolla, Rolla, Missouri*
(Received 31 May 1968)
35.5 p. 331

The characteristics of ion energies at the cathode are derived from collisional ionization cross sections for conduction between plane, parallel electrodes in rarefied gases, where the mean-free path is much greater than the cathode-anode separation. Expressions are given for the electron ionization efficiency, the ion particle-current density striking the cathode, the power density transferred to the cathode by the ions, and the average impacting ion energy. These expressions are given both for a homogeneous (single species) gas and for a heterogeneous mixture of gases. The latter can be obtained additively from the results obtained by treating each of the constituent gases individually. The maximum impacting ion energy is equivalent to the potential applied across the cathode and the anode; the minimum impacting ion energy is equivalent to the smallest first ionization potential of the gases present in the cathode-anode space.

The amount of ionization is discussed in terms of an "ionization volume" swept out by each of the bombarding electrons. By maximizing this volume with respect to the applied potential, the maximum amount of collisional ionization occurs in the cathode-anode space (a potential of approximately 200 V for most gases). Drawings of the typical shape of the ionization volume are given for applied potentials much less than, equal to, and much greater than, the applied potential which yields maximum ionization. A specific example demonstrating an application of the derivations is given, using argon as a model.

## Electronic Bubble States in Liquid Helium*

W. Beall Fowler
*Department of Physics, Lehigh University, Bethlehem, Pennsylvania*

and

D. L. Dexter
*University of Rochester, Rochester, New York*
(Received 7 June 1968)
34 p. 337

A calculation of the optical properties of electronic bubbles in liquid helium is presented. Making use of the measured well depth and surface tension, we have computed the electronic states as a function of bubble size and have calculated the configuration coordinate diagrams,

transition energies, oscillator strengths, lifetimes, cross sections, line shapes, linewidths, and estimated the magnitude of the static Jahn-Teller effect in an excited state. The dependence on pressure is considered for some of these quantities from 0–20 atm.

## Resonant Four-Wave Interaction of Electron-Plasma Oscillations*

R. C. Davidson†
*Department of Physics, University of California, Berkeley, California*
(Received 21 June 1968)
35 p. 344

The time evolution of a uniformly turbulent ensemble of electron fluids is studied in the electrostatic approximation. A kinetic equation for the action density is obtained in the long-wavelength limit, in which resonant four-wave processes cause the nonlinear transfer of energy in the oscillation spectrum. It is shown that the entire region of $\vec{k}$ space (within the limits of the simple-fluid model) is accessible to resonant four-wave interactions. Such four-wave mode coupling serves as a mechanism for the transfer of wave energy into shorter wavelengths.

## Liquid $^3$He. III. The Binding Energy and Other Properties at Zero Temperature*

E. Østgaard†
*Palmer Physical Laboratory, Princeton University, Princeton, New Jersey*
(Received 7 June 1968; revised manuscript received 25 September 1968)
34 p. 351

The binding energy of liquid $^3$He is estimated by separate calculations of the two-body and the three-body interaction energy. The two-body contribution is calculated by means of Brueckner theory, using a modified Brueckner-Gammel method. The approximation of a reference energy spectrum with an effective mass and quadratic momentum dependence is used for the input single-particle energy spectrum. The intermediate-state potential energies off the energy shell are chosen to be equal to zero, and the outer self-consistency requirement in the Brueckner method is neglected. A self-consistent solution is obtained, however, by the requirement that the input and the output energy spectrum for particles on the energy shell in the Fermi sea shall give the same two-body interaction energy.

The three-body contribution to the binding energy is estimated separately by methods originally developed for nuclear-matter calculations by Bethe and collaborators. Only the $S$-wave is properly taken into account. Third-order diagrams are also estimated separately.

For the Yntema-Schneider potential given by Brueckner and Gammel, we obtain a total binding energy for liquid $^3$He of $-1.0$°K per particle, which is in general agreement with other calculations. For the Frost-Musulin potential given by Bruch and McGee, we get $-2.0$°K per particle, which is closer to the experimental value.

Also, other low-temperature properties, such as the compressibility, the coefficient of thermal expansion, and the magnetic susceptibility, are estimated, with results in fair agreement with experimental values. The theoretical results are: 4.3% per atmosphere for the compressibility, $-0.10T$ (°K)$^{-1}$ ($T$ in °K) for the coefficient of thermal expansion, and $\approx 10$ for the magnetic susceptibility ratio. The quasiparticle effective mass, or equivalently the linear term in the temperature dependence of the specific heat, cannot be estimated very well with our methods.

## Low Excited States and Statistical and Transport Properties of Liquid $He^3$†

Hing-Tat Tan* and E. Feenberg
*A. H. Compton Laboratory of Physics, Washington University, St. Louis, Missouri*
(Received 8 July 1968; revised manuscript received 24 September 1968)
33.5
34 p. 370

The problem of liquid $He^3$ is studied under realistic conditions using the method of correlated basis functions. Two derivations are given of a formula for the energies of low states, including second-order interaction and orthonormalization effects. The ground-state energy, quasiparticle energies, and the quasiparticle interaction function are evaluated and used to compute the compressibility, velocity of first and zeroth sound, effective mass, magnetic susceptibility, coefficient of thermal expansion, and coefficients of thermal conductivity, viscosity, and spin diffusion. Results are compared with experiment and with earlier theoretical calculations.

## Phase Separation in Isotopic Fermi-Bose Mixtures

J. M. J. van Leeuwen* and E. G. D. Cohen
*Rockefeller University, New York, New York*
(Received 7 May 1968)
33
34 p. 385

An isotopic mixture of fermions and bosons has been investigated at a given pressure, using the hard sphere diameter $a$ as a perturbation parameter. The results agree with those obtained before at a given density. To first order in $a$ it is found that above a critical pressure the mixture separates into two coexisting phases. The phase separation curve has its top on the $\lambda$ curve of the mixture. The phase separation remains incomplete at $T=0$ for a wide range of densities. The slopes at the top and the behavior near $T=0$ of the phase separation curve have been computed. Also the osmotic pressure of dilute solutions has been obtained.

## Hydrodynamics and Time-Correlation Functions

James W. Dufty*
*Lehigh University, Bethlehem, Pennsylvania*
(Received 11 June 1968)
33
33.5 p. 398

The derivation of hydrodynamic equations, and their constitutive relations, by the time-correlation function method requires the reduction of general nonlocal equations to the usual local differential equations. This is accomplished by an approximation procedure generalizing the Chapman-Enskog method used in kinetic theory. We investigate here the validity of this method in the context of time-correlation functions characterizing hydrodynamic systems. It is pointed out that such correlation functions occurring in the nonlocal equations are not sharply peaked in space and time, as generally assumed in the literature. The procedure of expanding thermodynamic parameters and extracting their gradients from integrals over correlation functions is nevertheless shown to be valid for the systems considered. This is accomplished by demonstrating that the long-time parts of the correlation functions do not contribute, leaving the transport coefficients entirely determined by the microscopic or short-time parts. The mathematical requirements of the Chapman-Enskog procedure and the apparently contradictory analytic properties of the correlation functions for hydrodynamic systems are therefore resolved. No attempt is made to prove the assumed analytic behavior of the correlation functions from a specific force law.

≈ 10 for the magnetic susceptibility ratio. The quasiparticle effective mass, or equivalently the linear term in the temperature dependence of the specific heat, cannot be estimated very well with our methods.

systems are therefore resolved. No attempt is made to prove the assumed analytic behavior of the correlation functions from a specific force law.



## Study of Exciton Dynamics in a Simple Liquid

Sighart Fischer and Stuart A. Rice

*Department of Chemistry, and The James Franck Institute, The University of Chicago, Chicago, Illinois*, 60637

32.4
41

(Received 10 July 1968)

p. 409

A quantum-mechanical formulation of the theory of Frenkel excitons in a simple liquid is given with attention focused on the interaction of the exciton with the collective translational excitations of the liquid. Using a Born-Oppenheimer approximation to define a basis, the nonadiabatic term which describes the coupling of the exciton to the momentum density of the liquid is treated as a perturbation. It is shown, by use of Green's-function methods, that this coupling to the collective modes of the liquid is more important than is elastic scattering arising from the disorder in the system. The energy shift, damping, and the line shape of the Frenkel exciton are expressed in terms of the resonance interaction, the structure function, the translational kinetic energy of the liquid, and the lifetime of translational collective excitations.

## Multiphoton Ionization of Atomic Hydrogen

Wolfgang Zernik

RCA *Laboratories, Princeton, New Jersey*

11.2
14

(Received 23 August 1968)

p. 420

This is a comment on a recent publication by Gontier and Trahin. A comparison of our previously unpublished calculation with their result for the two-photon ionization of atomic hydrogen in the ground state shows significant numerical discrepancies.

## Superfluid Fraction of Liquid Helium Contained in Porous Vycor Glass*

J. C. Fraser and I. Rudnick

*Physics Department, University of California, Los Angeles, California*

34

(Received 29 July 1968)

p. 421

## Erratum

11.2
70

**Coupled-State Calculations of Proton-Hydrogen Scattering in the Sturmian Representation**, D. F. Gallaher and L. Wilets [Phys. Rev. 169, 139 (1968)]. p. 423

11.4
62.8
70

**Precise Theory of the Zeeman Spectrum for Atomic Hydrogen and Deuterium and the Lamb Shift**, Stanley J. Brodsky and Ronald G. Parsons [Phys. Rev. 163, 134 (1967)]. p. 423

12
70

**Evidence for the $^3\Delta_u$-$B^3\Pi_g$: Transition in $N_2$.** H. L. Wu and W. Benesch [Phys. Rev. 172, 31 (1968)]. p. 423

11.2
70

**Screened Coulomb Solutions of the Schrödinger Equation**, Carl A. Rouse [Phys. Rev. 159, 41 (1967)]. p. 423

11
33
61.4
70

**Finite Electronic Partition Function From Screened Coulomb Interactions**, Carl A. Rouse [Phys. Rev. 163, 62 (1967)]. p. 423

SECOND SERIES, VOL. 176, NO. 2 DECEMBER 1968

## Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10–180 MeV*

C. D. Moak, H. O. Lutz,† L. B. Bridwell,‡ L. C. Northcliffe,§ and S. Datz

*Oak Ridge National Laboratory, Oak Ridge, Tennessee*

13.2
27
47.6

(Received 24 July 1968)

p. 427

Monoenergetic bromine and iodine ions from the Oak Ridge tandem accelerator and an MP tandem accelerator have been used to investigate the variations of ionic charge states with various gaseous and solid target materials. In these measurements, beams containing a single charge state and energy were obtained by magnetic analysis and passed through solid targets or windowless gas targets before passing through an electrostatic analyzer. The electrostatic analyzer was fitted with a position-sensitive silicon surface-barrier detector. The most probable charge states are compared with the general relationships given by Dmitriev and Nikolaev. Strongly non-Gaussian distributions have been found at certain energies; most of these irregularities have been associated with ionic shell effects and with multiple ionization.

## Theory of Paramagnetic Impurity Spin Resonance in Metals*

M. B. WALKER

*Department of Physics, University of Toronto, Toronto, Canada*

21.2
46.6
(Received 25 March 1968)
p. 432

The frequency-dependent magnetic susceptibility describing the magnetic resonance of spin impurities in a metal is investigated theoretically, using thermodynamic Green functions and the Abrikosov diagram technique for spin operators. The single-particle pseudofermion propagator is shown to lead to formulas for the impurity spin energy-level shifts and widths which are identical, to all orders in perturbation theory, to those obtained in the standard quantum-mechanical theory of decaying states. The two-particle pseudofermion propagator describing impurity magnetic-resonance experiments is discussed, and it is shown that there are corrections to the interpretation of the magnetic resonance frequency shift and linewidth in terms of the individual level shifts and widths mentioned above. A perturbative evaluation of some of the formulas obtained shows that both the $g$ shift and the linewidth of the impurity spin resonance exhibit Kondo-like corrections depending on $\ln T$ when $kT > \hbar\omega_0, \omega_e$, or on $\ln\omega_0$ when $kT < \hbar\omega_0, \omega_0$ being the impurity spin-resonance frequency. The theory as developed is valid only when the conduction-electron spin-resonance frequency $\omega_e$ is sufficiently different from $\omega_0$, and it is shown that the contribution of the conduction-electron spin-magnetic moment to the absorption becomes increasingly important when this is not the case.

## Electron Spin Resonance of Free Radicals Formed from Group-IV and Group-V Hydrides in Inert Matrices at Low Temperature*

GEORGE S. JACKEL AND WALTER GORDY

*Department of Physics, Duke University, Durham, North Carolina*

21.2
48.6
(Received 1 July 1968)
p. 443

The electron-spin-resonance spectra of molecular free radicals formed from the group-IV and group-V hydrides at 4.2°K in the xenon matrix have been observed and compared with those observed in krypton and other matrices. From these spectra, certain properties of the free radicals and certain matrix effects have been derived. Molecular free radicals formed by $\gamma$ irradiation of a matrix containing $PH_3$ or $AsH_3$ are $PH_2$ and $AsH_2$, respectively. From analysis of the hyperfine structure, the P-bonding orbitals of $PH_2$ were found to have 20.6% 3$s$ character in the Xe matrix, compared with 19% in the Kr matrix. Because of anisotropies in the coupling and in the $g$ tensor the hyperfine structure of $AsH_2$ could not be measured. In the Xe matrix the average $g$ is 2.0050 for $PH_2$, and 2.034 for $AsH_2$. No spectra could be observed for $SbH_2$, although evidence for dissociation of $SbH_2$ was indicated by the strong H-atom lines observed for a $\gamma$-irradiated sample of $SbH_3$ in the Xe matrix. Molecular free radicals formed by $\gamma$ irradiation of the group-IV hydrides are $CH_2$, $SiH_2$, $GeH_2$, and $SnH_2$. The observed hyperfine structure caused by the isotopes $^{29}$Si, $^{73}$Ge, and $^{117,119}$Sn indicate that the radicals $SiH_2$, $GeH_2$, and $SnH_2$ are not planar like $CH_2$, but are pyramidal in structure. Noticeable difference in the isotropic coupling of $^{29}$Si for the Kr matrix, 240 G, and for the Xe matrix, 190 G, indicates strong interaction of the matrix with the $SiH_2$ radicals.

## Matrix Perturbations of the ESR of Trapped H, N, P, and As Atoms at 4.2°K*

GEORGE S. JACKEL, WILLIAM H. NELSON, AND WALTER GORDY

*Department of Physics, Duke University, Durham, North Carolina*

21.2
48.6
(Received 1 July 1968)
p. 453

Electron-spin-resonance spectra of N, P, As, and H atoms trapped in matrices formed from rare-gas elements at 4.2°K have been studied. The isotropic hyperfine coupling of N and P increases with the atomic number of the matrix element whereas that of As decreases. The van der Waals interaction theory devised by Adrian to explain the matrix effects on the nitrogen hyperfine splitting was generalized and applied with good success to the heavier group-V atoms. The results indicate that these group-V atoms occupy substitutional lattice sites, whereas the H atoms occupy octahedral sites. Recalculation of the matrix perturbations on nitrogen with more recent analytical self-consistent-field wave functions significantly improved agreement between theory and experiment. The isotropic $g$ factor of N, P, and As was found to be less than the free-spin $g$ and to decrease with increasing atomic number of the matrix elements. A weak fine structure observed for As atoms trapped in the Kr matrix is attributed to a small fraction of the atoms trapped in crystalline faults in the matrix.

## Symmetrical Formulation of the Quantum Theory of Three-Wave Optical Parametric Interactions*

C. Y. SHE†

*University of Minnesota, Minneapolis, Minnesota*

23
44.4
62.4
(Received 19 April 1968)
p. 461

The quantum theory of three-wave optical parametric interactions in a crystal such as $LiNbO_3$ is formulated in a symmetrical manner with respect to interaction time and distance. The formalism leads to a unique treatment of parametric interactions of both cavity type and propagation type, in that the resemblance between time in the cavity type and distance in the propagation type of interaction in the classical description is preserved. Three-wave effects of harmonic generation, parametric amplification (including spontaneous emission), and frequency conversion are treated in a unique and symmetric manner. Using Feynman's operator techniques, quantum states resulting from parametric interactions, previously unavailable, are derived, from which characteristics of the processes are deduced.

## Spin–Lattice Coupling Constants of an $Fe^{3+}$ Ion in MgO

R. R. SHARMA

*Department of Physics, University of Illinois, Chicago, Illinois*

21.2
22
48.6
(Received 27 May 1968)
p. 467

Estimates of the spin-lattice coupling constants of an $Fe^{3+}$ ion in the host crystal MgO have been made. There are only two independent coupling constants $C_{11}$ and $C_{44}$ in the simple case of a cubic lattice. Various possible mechanisms contributing to the coupling constants in the point-charge model have been investigated. It has been shown that the Blume-Orbach mechanism is the dominant one among the mechanisms considered. The next most important contribution arises from the spin-spin interaction mechanism proposed by Pryce. The other mechanisms which we have considered are found to give an entirely negligible contribution to the coupling constants. The combined point-charge contributions arising from all the mechanisms are, in units of $10^{-13}$ cm/dyn, $C_{11}$(point-charge) $= +2.11$ and $C_{44}$(point-charge) $= -3.06$, as compared with the experimental results, in the same units, $C_{11}$(expt) $= +26$ and $C_{44}$(expt) $= -5.5$, due to Feher. Also, the estimated overlap contributions to $C_{11}$ and $C_{44}$ are found to be an order of magnitude less than the point-charge contributions. Finally, some suggestions have been made in order to bring the theoretical results into better agreement with the experimental results.

## Nuclear Magnetic Resonance in the Metal $ReO_3$: $^{185}$Re and $^{187}$Re Knight Shifts and Spin Relaxation Rates*

ALBERT NARATH AND D. C. BARHAM

*Sandia Laboratory, Albuquerque, New Mexico*

21.4
46.4
46.6
(Received 9 August 1968)
p. 479

The nuclear magnetic resonances (NMR) of $^{185}$Re and $^{187}$Re in $ReO_3$ have been studied by pulsed-resonance techniques in the temperature range 1–4°K. The Knight shift, referred to aqueous $NaReO_4$, is found to be $K = (-0.25 \pm 0.02)\%$. The spin-lattice relaxation rates are directly proportional to the absolute tem-

elements at 4.2°K have been studied. The isotropic hyperfine coupling of N and P increases with the atomic number of the matrix element whereas that of As decreases. The van der Waals interaction theory devised

techniques in the temperature range 1–4°K. The Knight shift, referred to aqueous $NaReO_4$, is found to be $K=(-0.25\pm0.02)\%$. The spin-lattice relaxation rates are directly proportional to the absolute tem-



perature, with $T_1T=0.23\pm0.02$ sec °K for both isotopes. A comparison of these data with previous results for $^{183}W$ in the sodium tungsten bronzes $Na_xWO_3$ shows that the conduction-band states near the Fermi level are essentially identical in the two metals. The NMR results strongly support the view that these states are predominantly *d*-like.

## Energy-Loss Straggling of Protons in Silicon*

J. J. Kolata and T. M. Amos

*Michigan State University, East Lansing, Michigan*

and

Hans Bichsel

*University of Southern California, Los Angeles, California*

27
47.6
(Received 1 August 1968)
p. 484

The energy-loss straggling distributions for protons incident on a 200-$\mu$ silicon surface-barrier detector were measured in the energy region between 5 and 42 MeV. Experimental results were compared to the predictions of the Vavilov theory and found to be in excellent agreement at the higher energies. However, a systematic difference between theory and experiment was observed for proton energies less than 20 MeV, the discrepancy increasing with decreasing incident proton energy. This effect is due to appreciable variation of proton energy over the thickness of the detector. Tschalär's distribution functions, which specifically consider this variation, yield good fits to the data for energy losses as much as 80% of the incident proton energy.

## Theoretical Study on the Anisotropy of the Spin-Lattice Relaxation for Paramagnetic Ions in MgO Crystal

Santosh Kumar, T. Ray,* and D. K. Ray†

*Saha Institute of Nuclear Physics, Calcutta, India*

22
42.3
48.6
(Received 21 November 1967; revised manuscript received 17 June 1968)
p. 489

The anisotropy of the spin-lattice relaxation time with respect to the orientation of the Zeeman field about the crystal axes has been studied theoretically for $Co^{2+}$, $Ni^{2+}$, and $Cr^{3+}$ ions in an MgO crystal for both single- and two-phonon processes, using a Debye model of the phonon distribution. For the single-phonon process, the anisotropy in the relaxation time is large for $Co^{2+}$ but small for $Ni^{2+}$ and $Cr^{3+}$. For the double-phonon process, where the calculations are done without making the long-wavelength approximation, the relaxation time is totally isotropic for $Co^{2+}$, but for $Ni^{2+}$ and $Cr^{3+}$ it is slightly anisotropic. The deviation from the expected $T^{-7}$ law is found to be significant for the $Cr^{3+}$ ion. The effect of the dipolar interaction on the anisotropic factor for both single- and two-phonon processes is discussed.

## Microwave Properties of Granular Superconductors

Roger W. Cohen and J. I. Gittleman

*RCA Laboratories, Princeton, New Jersey*

41.4
42.2
(Received 31 July 1968)
p. 500

The microwave properties of a superconductor composed of small grains separated by tunneling barriers is calculated. In the absence of dc current, the ac conductivity is identical to that of a dirty superconductor. In the case of a nonvanishing current, the change in the conductivity due to the discontinuity in the phase of the energy-gap function across the tunneling barriers is smaller than that due to ordinary pair breaking.

## Modified Orbach Relaxation Process in a La(Cl, Br)$_3$ Matrix*

B. A. Young† and H. J. Stapleton

*Department of Physics and Materials Research Laboratory, University of Illinois, Urbana, Illinois*

21.2
43.3
48.6
(Received 15 July 1968)
p. 502

We have studied the spin-lattice relaxation rates of cerium and erbium in matrices of $La(1-x\ Cl, x\ Br)_3$. The substitution of $Br^-$ for $Cl^-$ in $LaCl_3$ was a technique for artificially introducing random local strains at the sites of paramagnetic impurities. The purpose was to test our earlier proposal that naturally occurring random strains were responsible for the frequent and sometimes large ($\approx$15%) discrepancies between the excited-state energy levels as measured by optical techniques and by spin-lattice relaxation. Our model assumes that the variation from site to site of $\Delta$, the first-excited-state energy of the paramagnetic ion, can be described by a Gaussian distribution, with a standard deviation $\sigma$, centered at the optically determined value. From our relaxation data we extract the value of $\sigma^2$ for each sample. We observe the theoretically predicted modifications to the temperature dependence of the Orbach relaxation mechanism as $\sigma^2$ changes with the degree of $Br^-$ substitution. Additional infrared and optical data, taken by other investigators on these samples, are briefly presented. These measurements give the actual distributions in $\Delta$, and the widths are found to be in excellent agreement with the values of $2\sigma$ inferred from our relaxation data.

## Circular One-Dimensional Model for the Electron-Ion System. I. Random-Phase Approximation

Gideon Carmi

*Belfer Graduate School of Science, Yeshiva University, New York, New York 10033*

41.1
41.4
46.1
(Received 18 May 1967; revised manuscript received 2 April 1968)
p. 510

This paper, which is first of a series about a system of "electrons" and "ions" constrained to move on a circle with an interaction potential whose Fourier transform is the inverse square of the momentum variable, applies the conventional tools of the equation of motion method in the random-phase approximation and Bardeen and Pines's canonical transformations, as well as the well-known Cooper-pair considerations. It is found that the model is in all ways similar to the three-dimensional electron-ion system: It displays collective modes (plasmons and phonons), screening, etc., with the familiar renormalization factors. The existence of a phonon-mediated attraction and the Cooper-pair analysis lead to the existence of bound pairs and an energy gap.

## Circular One-Dimensional Model for the Electron-Ion System. II. First-Order Phase Transitions in the Random-Phase Approximation

Gideon Carmi

*Belfer Graduate School of Science, Yeshiva University, New York, New York 10033*

41.1
41.4
46.1
(Received 26 January 1968)
p. 521

This paper is the second in a series on a model of "electrons" and "ions" on a circle, with interaction Fourier coefficients $1/n^2$ ($n$ integer). In this sequel to the random-phase-approximation (RPA) analysis of paper I, we show that the model undergoes, in the RPA, a first-order phase transition. This is shown by calculating the free energy $F$ from the partition function and demonstrating that $F$ is unstable with respect to the formation of a second phase. In the mechanism of the phase transition, it is crucial that quantum

theory ascribes discrete energy levels to the collective (plasma) degrees of freedom, which are unexcited or "frozen out" if the thermal energy is small with respect to the spacing of these discrete levels, and whose number $s$ furthermore depends on the temperature and density. Thus one obtains a system with an effective number of degrees of freedom, $N-s$, which increases as the temperature increases or the density decreases. This is taken heuristically as the feature underlying the possibility for the transition.

## Upper Critical Field of Two-Band Superconductors Containing Nonmagnetic Impurities

W. S. Chow
*Department of Physics, University of Cincinnati, Cincinnati, Ohio*

41.4
43.3
(Received 11 June 1968)
p. 525

By making use of a 4×4-matrix Green's function suitable for the two-band model of the superconducting phase of the transition metals, generalized 2×2-matrix Gor'kov equations are established. With these, Maki's theory of the upper critical field of one-band superconductors in the "dirty" limit is extended to the two-band model in the "dirty" limit and in the strong intraband phonon-coupling limit. It is found that in the temperature range between the $d$-band critical temperature and the $s$-band critical temperature, the upper critical field is uniformly decreased because of the interband impurity scattering. The general behavior of the upper critical field as a function of temperature is discussed.

## Motion of Normal Regions Along a Superconducting Strip*

John R. Clem
*Institute for Atomic Research and Department of Physics, Iowa State University, Ames, Iowa 50010*

(Received 22 May 1968)
41.4
p. 531

The local temperature and heat current density in a superconducting strip whose ends are maintained at constant temperature are calculated for the case of periodically repeating motion of magnetic-flux-containing normal regions along the strip. The effective transport entropy per unit length per flux quantum, associated with the motion, is calculated; reasonable agreement with experiment is found. The power dissipation arising from the presence of temperature gradients is found to be small by comparison with the electrical dissipation in pure, but not in impure, superconductors. The presence of local thermal gradients is estimated to have an important influence upon the thermogalvanomagnetic effects in superconductors.

## Magnetic-Field Dependence of Radio-Frequency Flux Penetration in Type-II Superconductors*

D. E. Carlson†‡ and W. L. McLean
*Physics Department, Rutgers—The State University, New Brunswick, New Jersey*

(Received 12 August 1968)
41.5
p. 538

The magnetic-field dependence of the penetration of radio-frequency fields has been measured in type-II superconductors. We discuss information obtained concerning the mixed state, the superconducting surface sheath, and superconducting cylindrical thin films. Some of the results, such as structure near $H_{c2}$, are interpreted in terms of vortex motion and effects of the sheath. Results pertaining to the sheath are compared with the calculations of Fink and Kessinger and of Maki. Other results in the mixed state are related to surface impedance calculations of Maki and of Caroli and Maki, based on the microscopic theory. Penetration depth measurements in the films agree better with a naive model than with Pincus's theory.

## Anomalous Thermal Conductivity of Superconductors due to Impurity Spin Ordering

K. H. Bennemann
*Department of Physics and Astronomy, University of Rochester, Rochester, New York**
and
F. M. Mueller
*Argonne National Laboratory, Argonne, Illinois†*

(Received 23 April 1968)
41.4
p. 546

It is shown that spontaneous and also a magnetic-field-induced ordering of the paramagnetic impurity spins in superconductors gives rise to an anomalous temperature dependence of the electronic thermal conductivity.

## Simple Microscopic Theory of Surface Plasmons

Peter J. Feibelman*
*Service de Physique Théorique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, France*

41.1
46.1
(Received 27 June 1968)
p. 551

We give a simple microscopic description of the surface modes of a finite high-density electron liquid. The random-phase approximation is reduced to a second-order differential equation with a surface solution at the expected frequency. We discuss the excitation of the surface plasmons, and also describe the analogous modes of systems with a short-range interaction.

## Superconductivity of α-Phase U–Mo Alloys at Zero and High Pressures

J. E. Gordon*
*Physics Department, Amherst College, Amherst, Massachusetts 01002*
and
W. E. Gardner and T. F. Smith
*Materials Physics Division, Atomic Energy Research Establishment, Harwell, Didcot, Berkshire, England*
and
C. W. Chu* and M. B. Maple†
*Physics Department, University of California, San Diego, La Jolla, California 92037*

(Received 26 July 1968)
41.5
p. 556

Heat-capacity measurements and determinations of the superconducting transition temperature as a function of applied pressure up to 10 kbar have been made on a number of α-phase uranium-molybdenum alloys. Small additions of molybdenum rapidly change the superconducting properties of the $\alpha$ phase. The strong initial pressure dependence of $T_c$ for pure α-U is destroyed, and bulk superconducting behavior at zero pressure develops.

pared with the calculations of Fink and Kessinger and of Maki. Other results in the mixed state are related to surface impedance calculations of Maki and of Caroli and Maki, based on the microscopic theory. Penetration depth measurements in the films agree better with a naive model than with Pincus's theory.

alloys. Small additions of molybdenum rapidly change the superconducting properties of the $\alpha$ phase. The strong initial pressure dependence of $T_c$ for pure $\alpha$-U is destroyed, and bulk superconducting behavior at zero pressure develops.



## Precision Measurement of Anisotropy in the Upper Critical Field of Superconducting Niobium*

D. E. Farrell, B. S. Chandrasekhar, and S. Huang†
*Department of Physics and Condensed State Center, Case Western Reserve University, Cleveland, Ohio*
(Received 11 July 1968)
41.5 p. 562

A sensitive vibrating-coil magnetometer has been employed to investigate anisotropy in the upper critical field of pure niobium from 1.2°K to the transition temperature. The results are analyzed using a four-term Kubic harmonic expansion. This is sufficient to represent the data to within experimental error above a reduced temperature of $t \simeq 0.5$, although as the temperature is reduced, small but systematic deviations occur, indicating the presence of higher harmonics. The temperature dependences of the first four harmonics are presented and discussed. Both the temperature dependence of the $n$th harmonic, and the reduction of that harmonic by impurity scattering, increase as $n$ increases. Our observations are in qualitative accord with the detailed theory for upper-critical-field anisotropy due to Hohenberg and Werthamer. Where direct comparison is possible quantitative agreement is also obtained.

## Fluxoid Quantization and Field-Induced Depairing in a Hollow Superconducting Microcylinder*

R. P. Groff† and R. D. Parks
*Department of Physics and Astronomy, University of Rochester, Rochester, New York*
(Received 24 June 1968)
41.5 p. 567

Little and Parks demonstrated that the superconducting transition temperature $T_c$ of a multiply connected superconductor is periodic in a magnetic field with a periodicity of $hc/2e$. However, there were certain anomalous features of the early experiments, such as an unexplained temperature dependence of the amplitude of the $\Delta T_c$ oscillations and an unexplained nonoscillatory magnetic field background superposed on the oscillatory field dependence of $T_c$. By repeating the experiment under more controlled conditions, we have eliminated the problems which led to the anomalous features of the early results. Isothermal resistance-versus-magnetic-field measurements were made on Sn and Al cylinders of various diameters in the range 1–5 $\mu$. From these measurements detailed phase diagrams ($T_c$-versus-$H$ curves) were constructed which are in excellent agreement with the predictions of the linearized Ginzburg-Landau theory. The present type of experiment is shown to be suitable for studying depairing due to kinetic-energy effects associated with the drift motion of Cooper pairs. The results are discussed within the framework of the pair-breaking theory of Abrikosov and Gor'kov, which has been adapted to treat the present problem.

## High-Frequency Surface Impedance of Dirty Type-II Superconductors in the Surface-Sheath Regime

Gaston Fischer*
*Laboratories RCA Ltd., 8005 Zurich, Switzerland*
and
Kazumi Maki
*Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan*
41.5
42.2
43.5
(Received 18 July 1968)
p. 581

Surface-resistance measurements in the superconducting surface-sheath regime of Pb–In and Pb–Bi alloys are analyzed in the light of the recent theories of dirty type-II superconductors. From the changes of slope of the surface resistance $R(H)$ at $H_{c3}$, the temperature dependence of the $\kappa_2$ parameter can be deduced. For the alloys investigated, it is found that $\kappa_2$ varies more strongly with temperature than expected from the dirty-limit theory. It is believed that this reflects strong-coupling effects. From the value of $R(H)$ at $H_{c3}$, the absolute value of the sheath thickness can also be derived. This is found to agree well, near $T_c$, with the theoretical predictions of Fink and Kessinger. The analysis of the experimental data suggests that weak-coupling formalism remains applicable in the strong-coupling limit, and that deviations appear as modified temperature dependences of the critical fields. The $H_{c3}(t)$ and $H_{c2}(t)$ found for the two alloys are nevertheless rather close to the weak-coupling predictions.

## Electron Correlations at Metallic Densities*

K. S. Singwi, M. P. Tosi, and R. H. Land
*Argonne National Laboratory, Argonne, Illinois*
and
A. Sjölander
*Institute of Theoretical Physics, Chalmers University of Technology, Gothenburg, Sweden*
33
41.1
46.1
(Received 26 April 1968)
p. 589

The dielectric function of a degenerate electron gas in the random-phase approximation, and the one proposed by Hubbard, which takes exchange effects into account, have been extensively used in the study of metallic properties. However, both dielectric functions lead to an overestimate of the short-range correlations between particles. This is manifest from the fact that the pair-correlation function is negative for small interparticle separations over the whole range of metallic densities, and implies an overestimate of the correlation energy. An improved expression of the dielectric function is given, which includes explicitly, in an approximate way, the short-range correlations arising from both Coulomb and exchange effects by being a functional of the structure factor. The structure factor and the dielectric function can then be determined in a self-consistent manner. The numerical solution of the self-consistent scheme yields a pair-correlation function which is positive for all values of the density up to $r_s = 4$. For $r_s > 4$, it is very slightly negative at small separations, but it is so small that it can be considered to be zero for all practical purposes. New estimates of the correlation energy are given for the entire metallic density range, and are smaller than the earlier estimates. These results are used to recalculate the cohesive energy of the alkali metals. A discussion of the plasmon dispersion relation, the compressibility, and the liquid-solid transition, both for the electron system and for an astrophysically interesting system of protons over a background of electrons, is also given.

## Ground-State Energy of the Anderson Model by the Cluster Variation Method

Shyamalendu M. Bose
*Department of Physics, The Catholic University of America, Washington, D. C. 20017*
and
Tomoyasu Tanaka
*Department of Physics, The Catholic University of America, Washington, D. C. and U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland*
43.3
46.3
49.3
(Received 23 July 1968)
p. 600

The Anderson Hamiltonian has been treated by the application of the cluster variation method for the cooperative phenomena, which was first proposed by Kikuchi and later generalized by Morita. The calculation has been carried out by retaining up to two-particle off-diagonal correlations. The self-consistent

equations obtained for the number of $d$ electrons with opposite spins are found to have similar behavior and similar self-consistent solutions to those of Anderson. The ground-state energy of this system has been calculated for the cases of infinite $d$-$d$ correlation energy and for a $d$-$d$ correlation energy twice the energy of the $d$ orbital. This ground-state energy is found to be lower than the free-electron energy by an amount $2N(0)D^2\exp[-|\epsilon_d|/N(0)|V|^2]$, where $N(0)$ is the density of conduction states of one spin at the Fermi surface, $D$ is the conduction bandwidth, $\epsilon_d$ is the energy of the $d$ orbital measured from the Fermi surface, and $V$ is the mixing strength between the conduction-electron states and the $d$ orbital.

## Effect of Orbital Quantization on the Critical Field of Type-II Superconductors

L. W. Gruenberg*
*Department of Electrical Engineering and Center for Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139*
AND
L. Gunther†
*Department of Physics, Tufts University, Medford, Massachusetts 02155*
(Received 1 July 1968)
41.4 p. 606

We discuss the effect of the discreteness of the Landau levels on the upper critical field of a type-II superconductor. At $T=0$°K an ideal superconductor will remain superconducting in an arbitrarily large magnetic field. However, the high-field state is destroyed by a minute amount of impurity scattering or by a small misalignment of up- and down-spin Landau levels. The residual effects are (a) a small shift in the low-temperature critical field $[\Delta H_{c2}/H_{c2}\approx(k_F l)^{-1}]$ and (b) oscillatory structure in the transition temperature $T_{c2}(H)$ for temperatures $T\lesssim\hbar\omega_c/2\pi^2 k$.

## Magnetic Properties of Gold-Rich Gold-Vanadium Alloys*

L. Crevelino, Jr., and H. L. Luo†
*Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92037*
(Received 20 May 1968)
46.4
49.4 p. 614

Results of measurements on Au–V alloys are presented. The intermetallic compound $Au_4V$, formed through an order-disorder transformation at 560°C, becomes ferromagnetic at ≈60°K. Above that temperature the susceptibility satisfies a Curie-Weiss law. The induced moment at absolute zero, the effective moment, the transition temperature, and the temperature-independent component of the susceptibility all vary from sample to sample, but typical values are $0.5\mu_B$ per V ion, 1.7, 50°K, and $150\times10^{-6}$ emu/(g at. wt), respectively. The variation is thought to be due to extreme magnetic hardness coupled with a high degree of crystal imperfection. All results indicate that a model of localization in the molecular-field approximation is adequate to describe the ferromagnetism. In agreement with earlier work, dilute solid solutions of V in Au have temperature-dependent susceptibilities. The susceptibilities are describable by a Curie-Weiss law, with parameters that vary with concentration and heat treatment. Temperature dependence occurs only in the concentration range ≈0.1 to 30 at.% V; the Curie constant reaches a maximum value at 5–10 at.% V. A model is presented which can account for the results observed by assuming that a V ion localizes in Au only if there are no V neighbors within a critical distance. In conclusion, the implications for the possible existence of other ferromagnetic intermetallic compounds are discussed.

## Theory of a Two-Dimensional Ising Model with Random Impurities. I. Thermodynamics

Barry M. McCoy
*Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11790*
AND
Tai Tsun Wu*
*Gordon McKay Laboratory, Harvard University, Cambridge, Massachusetts 02138*
(Received 9 July 1968)
41.2
41.3
49.3 p. 631

Recent experiments demonstrate that at the Curie temperature the specific heat may be a smooth function of the temperature. We propose that this effect can be due to random impurities and substantiate our proposal by a study of an Ising model containing such impurities. We modify the usual rectangular lattice by allowing each row of vertical bonds to vary randomly from row to row with a prescribed probability function. In the case that this probability is a particular distribution with a narrow width, we find that the logarithmic singularity of Onsager's lattice is smoothed out into a function which at $T_c$ is infinitely differentiable but not analytic. This function is expressible in terms of an integral involving Bessel functions and is computed numerically.

## Theory of Anisotropic Spontaneous Magnetization and Anisotropy Energy in Orthorhombic Ferromagnets at 0°K

George T. Rado
*Naval Research Laboratory, Washington, D.C. 20390*
(Received 8 July 1968)
41.3
49.1 p. 644

A new mechanism of anisotropic spontaneous magnetization is proposed. It consists of the mutual admixture, due to perturbations caused by one-ion anisotropy, of appropriate eigenstates of the Hamiltonian describing the molecular-field energy. A self-consistent method is developed in which the anticipated anisotropic part of the spontaneous magnetization contributes to the molecular field, and the direction of the spontaneous magnetization is fixed by an applied field. Using the quadratic parts of the one-ion spin Hamiltonian as the perturbation, the first- and second-order portions of the anisotropic spontaneous magnetization and anisotropy energy are calculated for an orthorhombic ferromagnet at 0°K. It is pointed out, however, that the present method applies to other perturbations also. The calculation shows, among other things, that higher-order perturbations do usually contribute to first-order anisotropy constants. This result is contrary to accepted conclusions contained in the literature. The predictions of the present theory are compared with those of others, and its possible generalizations and applicability to experiments are discussed. Finally, the first-order portion of the anisotropic spontaneous magnetization and anisotropy energy arising from an anisotropic $g$ factor are calculated and compared with experimental data on gallium iron oxide.

## Phenomenology of Neutron Scattering in Heisenberg Systems

Herbert S. Bennett
*National Bureau of Standards, Washington, D. C. 20234*
(Received 15 July 1968)
41.2
49.1 p. 650

The magnetic scattering of neutrons from Heisenberg systems is discussed within the rigorous framework of spectral representations for the longitudinal and transverse spectral weight functions, low-order moments of these functions, and their sum rules. The spectral weight functions are expressed as functionals

assuming that a V ion localizes in Au only if there are no V neighbors within a critical distance. In conclusion, the implications for the possible existence of other ferromagnetic intermetallic compounds are discussed.

The magnetic scattering of neutrons from Heisenberg systems is discussed within the rigorous framework of spectral representations for the longitudinal and transverse spectral weight functions, low-order moments of these functions, and their sum rules. The spectral weight functions are expressed as functionals



of longitudinal and transverse diffusivities. This exact framework leads naturally to a two-parameter phenomenological description of the neutron-scattering cross section in Heisenberg ferromagnets. It is shown that replacing the diffusivities by two-parameter Gaussian functions, which satisfy the first two sum rules, gives the essential features for the neutron-scattering cross section in ferromagnets.

## Free Energy of Interacting Magnetic Dipoles*

ROBERT B. GRIFFITHS†
*Physics Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213*

33
41.3
49.1

(Received 5 August 1968)

p. 655

A system of spins on a lattice with magnetic dipole-dipole interactions, exchange, and anisotropy forces is shown to possess a well-defined bulk free energy, independent of sample shape, in the thermodynamic limit, provided there is no external magnetic field. The proof applies to classical or quantum spin systems with arbitrary $g$ tensors, and is independent of any assumption of order or disorder in the magnetic phase, convergence of perturbation series, etc.

## Linear Chain Antiferromagnetism in $CsMnCl_3 \cdot 2H_2O$†

T. SMITH* AND S. A. FRIEDBERG
*Physics Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213*

41.3
49.1
49.7

(Received 22 July 1968)

p. 660

The magnetic susceptibilities of orthorhombic single crystals of $CsMnCl_3 \cdot 2H_2O$ have been measured along the $a$, $b$, and $c$ axes between 0.35 and 77°K. Above ~9°K, the susceptibility is essentially that of a system of extended weakly interacting chains of spins ($S=\frac{5}{2}$, $g=2.00$) antiferromagnetically coupled by nearest-neighbor Heisenberg exchange interaction. The magnitude of the intrachain interaction has been deduced by comparison with Fisher's classical limiting form of the theory of the Heisenberg chain, with and without corrections for the finite spin of the $Mn^{++}$ ion. With such corrections one finds $J=-3.00k$. A small uniaxial anisotropy evident at hydrogen temperatures is attributed primarily to single-ion effects. Below ~5°K, interchain interaction apparently causes long-range antiferromagnetic ordering, with the $a$ axis the preferred direction of spin orientation. At 0.35°K an anomalous temperature dependence of uncertain origin is seen.

## Specific Heat of Uranium Mononitride from 1.3 to 4.6°K*

J. O. SCARBROUGH, H. L. DAVIS, W. FULKERSON, AND J. O. BETTERTON, JR.
*Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

42.2
46.4
49.4

(Received 8 July 1968)

p. 666

The specific heat of uranium mononitride was measured at temperatures from 1.3 to 4.6°K and was found to be of the form $\gamma T+\beta(T/\Theta_D)^3$, where $\gamma$ is 24.79±0.05 mJ(g at. wt)$^{-1}$(deg)$^{-2}$ and the Debye $\Theta$ is 324±7°K. The large value of $\gamma$ (35 times the value for copper) apparently results from the Fermi surface intersecting narrow $5f$ electronic bands. The above values refer to a UN sample heat-treated in an atmosphere of nitrogen for 6.5 h at 2250°C. The same sample, before this heat treatment, had a measured $\gamma=24.07\pm0.08$ mJ(g at. wt)$^{-1}$(deg)$^{-2}$ and $\Theta=322\pm13$°K. The shift in $\gamma$ may be due to a small change in stoichiometry caused by the heat treatment. Although the Debye temperature obtained from the present work, 324°K, is larger than previous specific-heat estimates of 276–289°K, it is lower than the value of 364°K obtained from velocity-of-sound measurements. No changes were observed in the specific heat upon application of magnetic fields up to 35 kG, suggesting the absence of any appreciable magnetic contribution to the total specific heat for temperature below 4.7°K.

## High-Field Galvanomagnetic Effects in Antiferromagnetic Chromium*†

A. J. ARKO‡ AND J. A. MARCUS
*Northwestern University, Evanston, Illinois*§
AND
W. A. REED
*Bell Telephone Laboratories, Murray Hill, New Jersey*

46.4
49.4
49.5

(Received 22 July 1968)

p. 671

The effects of the antiferromagnetic spin-density wave on the Fermi surface of Cr have been investigated by measurement of the high-field galvanomagnetic properties of pure single-domain crystals of Cr (residual resistance ratios from 750 to 1760) in fields up to 200 kOe. The topological features of the Fermi surface are shown to be consistent with a single direction of open orbits parallel to **Q**, the wave vector of the spin-density wave, in agreement with the Lomer model of the Fermi surface. Magnetic breakdown through the superlattice energy gaps is observed in the 0–20-kOe range and again in the 60–200-kOe range for all orientations of **H**. Theoretical calculations by Falicov and Zuckermann suggest that the breakdown is probably occurring through the second- and first-order gaps. An estimate of the breakdown fields is made by comparing our results with the theoretical curves of Falicov and Sievert. The value of the energy gaps depends sensitively on the type of energy bands assumed, but a lower bound for first-order gaps is ~0.05 eV. Measurements on multidomain crystals and the effects of a compressive stress are also discussed.

## Magnetic Scattering of Electrons from Crystals and Polarization of the Scattered Beam

LAWRENCE A. VREDEVOE AND ROGER E. DE WAMES
*Science Center/Aerospace and Systems Group, North American Rockwell Corporation, Thousand Oaks, California*

42.1
49.2

(Received 1 July 1968)

p. 684

The role played by the exchange interaction in the scattering of electrons from magnetic crystals has not been fully appreciated until recently. In this paper, we show that the interference between the Coulomb and the exchange scattering potentials can lead to large polarizations of a beam of elastically scattered low-energy electrons. A double-scattering experiment that can measure this effect is described.

## Theory of Transition-Metal Complexes: Unrestricted Hartree–Fock Molecular-Orbital Method and Its Application to $KNiF_3$†

D. E. Ellis*

*Solid State and Molecular Theory Group, Massachusetts Institute of Technology, Cambridge, Massachusetts and Department of Physics, University of Florida, Gainesville, Florida*

AND

A. J. Freeman‡

*Francis Bitter National Magnet Laboratory,§ Massachusetts Institute of Technology, Cambridge, Massachusetts*

AND

P. Ros¶

*Solid State and Molecular Theory Group, Massachusetts Institute of Technology, Cambridge, Massachusetts*

44.1
48.4
49.4

(Received 15 December 1967)

p. 688

The unrestricted Hartree-Fock molecular-orbital self-consistent-field (MO-SCF) method is developed and applied to the problem of transition-metal ion clusters. This method removes many of the shortcomings of earlier treatments and provides, in principle, a framework for obtaining fairly accurate and meaningful results. Model calculations are reported for the $KNiF_3$ system, in which all matrix elements of the Hamiltonian are accurately computed (by the choice of a special one-center basis set) for all the electrons of the molecular cluster. Considerable variational freedom is allowed in all representations; as a consequence, significant covalent mixing is found for representations containing the metal $3s$ and $3p$ orbitals. This molecular-orbital approach thus differs greatly from the previous approach of using molecular orbitals formed as linear combination of atomic orbitals (MO-LCAO); in particular, it is emphasized that the simple (and inadequate) *single*-variational-parameter LCAO treatment of earlier calculations is replaced by full HF-SCF calculations in a multielectron framework including all electrons (and not just the bonding and antibonding electrons as in earlier treatments). Complete SCF calculations are carried out for both the $(NiF_4)^{4-}$ and the $(Ni_2F)^{6+}$ clusters (representing the metal-ion and the ligand-ion point of view, respectively) including the effects of an external crystalline field. Although these first (crude) calculations suffer from limited basis size, reasonable agreement with experiment is found for such quantities as the optical-splitting parameter $10Dq$, the transferred hyperfine interaction, and the neutron magnetic form factor.

## Heat Capacity of $Mn(CH_3COO)_2\cdot 4H_2O$ between 0.4 and 20°K*

J. H. Schelleng,† C. A. Raquet,‡ and S. A. Friedberg

*Department of Physics, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213*

49.1
49.4

(Received 8 July 1968)

p. 708

The heat capacity $C_p$ of powdered specimens of $Mn(CH_3COO)_2\cdot 4H_2O$ has been measured between 0.4 and 20°K in two vacuum calorimeters, one of which was cooled with liquid $He^3$. A sharp λ-like anomaly occurs at 3.18°K, the magnetic ordering temperature. The behavior of this peak upon application of a magnetic field supports the conclusion that the ordered phase is ferrimagnetic. Near 0.7°K, $C_p$ exhibits a rounded anomalous maximum of the Schottky type. This probably reflects the inequivalence of $Mn^{++}$ ions within the unit cell. It is suggested that one group of $Mn^{++}$ ions may interact only weakly with another group which are comparatively strongly coupled to one another.

## Neutron Diffraction and Susceptibility Study of Dilute La–Rare-Earth Alloys*

D. K. Finnemore, L. J. Williams, F. H. Spedding, and D. C. Hopkins

*Institute for Atomic Research and Department of Physics, Iowa State University, Ames, Iowa 50010*

43.3
49.3
49.4

(Received 7 June 1968)

p. 712

Neutron diffraction and susceptibility data are reported for dilute solutions of rare-earth impurity in a La host. At magnetic impurity levels of 10 and 20 at.%, the La-Tb alloys show a broad neutron diffraction peak characteristic of short-range order at 7° from the forward direction. At a magnetic impurity level of 5 at.%, this short-range order peak is absent, and the magnetic scattering in the ordered state is the same as the scattering in the paramagnetic state. Within experimental error, the Tb ions maintain their full moment and there is no change in the scattering which can be associated with spin compensation by the conduction electrons. Susceptibility data for these alloys are in many respects similar to results reported for Cu-Mn alloys, but there are important quantitative differences. Pure double-hcp La shows a nearly temperature-independent susceptibility in fair agreement with that predicted from the specific-heat density of states.

## Spherical Model as the Limit of Infinite Spin Dimensionality

H. E. Stanley

*Lincoln Laboratory,* Massachusetts Institute of Technology, Lexington, Massachusetts*

*and*

*Physics Department, University of California, Berkeley, California*†

33
41.2
41.3

(Received 20 April 1968)

p. 718

The Berlin-Kac spherical model (or "spherical approximation to the Ising model")

$$\mathcal{H}^{SM} = -J\sum_{(ij)}\mu_i\mu_j, \quad \text{with} \quad \sum_{i=1}^{N}\mu_i^2 = N,$$

is found to be equivalent to the $n\to\infty$ limit of the Hamiltonian

$$\mathcal{H}^{(n)} = -J\sum_{(ij)}\mathbf{S}_i^{(n)}\cdot\mathbf{S}_j^{(n)},$$

where $\mathbf{S}_i^{(n)}$ are isotropically interacting $n$-dimensional classical spins.

## Magnetic Structures of $Er_2O_3$ and $Yb_2O_3$†

R. M. Moon, W. C. Koehler, H. R. Child, and L. J. Raubenheimer*

*Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee*

49.2
49.4

(Received 21 June 1968)

p. 722

The magnetic structures of $Er_2O_3$ and $Yb_2O_3$ have been determined by analysis of neutron diffraction data on powders and single crystals. Noncollinear antiferromagnetic structures were found, with the moment direction related to the local symmetry axis. For $Er_2O_3$, the moment on the $C_2$ site is $(5.36\pm0.08)\mu_B$ and at the $C_{3i}$ site the moment is $(6.06\pm0.23)\mu_B$. For $Yb_2O_3$, the corresponding moments are $(1.86\pm0.06)\mu_B$

anomalous maximum of the Schottky type. This probably reflects the inequivalence of $Mn^{++}$ ions within the unit cell. It is suggested that one group of $Mn^{++}$ ions may interact only weakly with another group which are comparatively strongly coupled to one another.

on powders and single crystals. Noncollinear antiferromagnetic structures were found, with the moment direction related to the local symmetry axis. For $Er_2O_3$, the moment on the $C_3$ site is $(5.36\pm0.08)\mu_B$ and at the $C_{2h}$ site the moment is $(6.06\pm0.23)\mu_B$. For $Yb_2O_3$, the corresponding moments are $(1.86\pm0.06)\mu_B$



and $(1.05\pm0.06)\mu_B$. The Néel points are 3.4°K for $Er_2O_3$ and 2.3°K for $Yb_2O_3$. Calculations of the dipole-dipole energies for the observed structures indicate that the dipole forces are not sufficient to explain the structures. The dependence of the long-range magnetic order on the reduced temperature is the same in both systems. Good agreement with this temperature dependence was obtained by assuming a biquadratic exchange interaction and making a simple molecular-field approximation.

## Nuclear-Magnetic-Resonance Study of the Ferroelectric Transitions in $NaH_3(SeO_3)_2$ and $NaD_3(SeO_3)_2$

R. Blinc, J. Stepišnik, and I. Zupančič

*The University of Ljubljana and Nuclear Institute "J. Stefan," Ljubljana, Yugoslavia*

21.4 49.6 49.8

(Received 23 April 1968)

p. 732

The angular dependences of the proton, deuteron, and $Na^{23}$ magnetic-resonance spectra have been measured as a function of temperature in both normal (STSe) and deuterated (D–STSe) sodium trihydrogen selenite, and the electric field gradient tensors at the sodium and deuteron sites have been determined. These data show that the two ferroelectric transitions in STSe $(2/m\rightarrow1\rightarrow m)$ are accompanied by a doubling of the unit-cell edges in the $a$ and $b$ directions with respect to the paraelectric unit cell, whereas there is just one transition in D–STSe $(2/m\rightarrow m)$, which is connected with a doubling in the $b$ direction only. The triclinic ferroelectric phase which exists in STSe between $-79$ and $-173$°C thus does not appear in D–STSe. The transitions are accompanied by an ordering of hydrogens (which in the paraelectric phase are rapidly jumping from one equilibrium site in the H bond to another) as well as by a distortion of the $SeO_3^-$ and $Na^+$ network.

## High-Temperature Critical Indices for the Classical Anisotropic Heisenberg Model

David Jasnow and Michael Wortis*

*Department of Physics, University of Illinois, Urbana, Illinois 61801*

41.2 41.3

(Received 15 July 1968)

p. 739

High-temperature series expansions for the spin-spin correlation function of the classical anisotropic Heinsenberg model are calculated for various lattices and anisotropies through order $T^{-8}$ (close-packed lattices) and $T^{-6}$ (loose-packed lattices). These series are combined and then extrapolated to give the high-temperature critical indices $\gamma$ (susceptibility), $\nu$ (correlation range), and $\alpha$ (specific heat) as functions of anisotropy. Our results are consistent with the hypothesis that the critical indices change only when there is a change in the symmetry of the system, e.g., in interpolating between the Ising and isotropic Heisenberg models, indices remain Ising-like until the system becomes isotropic, at which point they appear to change discontinuously. Previous results for the limiting cases are confirmed and extended.

## Critical Behavior of the Ising, *XY*, and Heisenberg Ferromagnets on the *B*-Site Spinel Lattice*

David Jasnow and M. A. Moore†

*Department of Physics, University of Illinois, Urbana, Illinois*

41.2 41.3

(Received 19 July 1968)

p. 751

The critical properties of the Ising and the classical $XY$ and Heisenberg ferromagnets on the $B$-site spinel lattice are studied by the method of exact high-temperature series expansions. Eight terms are obtained for each model in the susceptibility and second-moment series. Analysis of these series shows that the anomalies in the critical indices reported by Stanley and Kaplan using only six terms disappear with the use of longer series.

## Transport Properties of Thulium Single Crystals*

L. Roger Edwards† and Sam Legvold

*Institute for Atomic Research and Department of Physics, Iowa State University, Ames, Iowa 50010*

49.4 49.5

(Received 28 March 1968)

p. 753

Single crystals of thulium have been grown by the strain-anneal technique. The electrical resistivity, thermal conductivity, and Seebeck coefficients were measured along the $\langle11\bar{2}0\rangle$ ($a$-axis), $\langle10\bar{1}0\rangle$ ($b$-axis), and $\langle0001\rangle$ ($c$-axis) crystallographic directions as a function of temperature from 5 to 300°K. All measurements indicated a magnetic transition near 57°K, in good agreement with a Néel temperature of 56°K as determined in earlier work by the Oak Ridge National Laboratory neutron diffraction group. The Seebeck coefficient measured along the $c$ axis exhibited a second anomaly at 32°K, in agreement with low-field ac susceptibility measurements; but this anomaly did not appear in the neutron-diffraction measurements. The anomalies observed in the electrical resistivity and thermal conductivity at the Néel temperature are interpreted in terms of magnetic superzone planes. All transport properties exhibited a significant anisotropy between the $a$- or $b$-axis and $c$-axis directions. The high-temperature anisotropy of the electrical resistivity and the thermal conductivity is interpreted in terms of the anisotropy of the Fermi surface.

## Errata

41.3 42.2 70

**Surface Effects in the Heisenberg Antiferromagnet,** D. L. Mills and W. M. Saslow [Phys. Rev. **171**, 488 (1968)]. p. 760

SECOND SERIES, VOL. 176, NO. 3 DECEMBER 1968

## Anisotropic Relaxation Times and the Hall Coefficients of α-Phase Alloys of the I*B* Metals

R. D. Barnard,* J. E. A. Alderson, T. Farrell,† and C. M. Hurd
*Division of Applied Chemistry, National Research Council of Canada, Ottawa, Canada*

45.4
46.5
(Received 16 August 1968)
p. 761

The Hall coefficient ($R_H$) of polycrystalline, α-phase alloys of the I*B* metals has been determined in the range 10–300°K. $R_H$ shows a dependence upon temperature and solute concentration which might be regarded as very unexpected in a system of monovalent constituents with similar electronic structures. However, it is shown that the data can be interpreted semiempirically in terms of a two-band model which includes different anisotropies of the relaxation times associated with impurity and phonon scattering. Estimates of these anisotropies are obtained for each system and are shown to be in relatively good agreement with those obtained from a similar analysis of deviations from Matthiessen's rule.

## Absolute de Haas–van Alphen Frequency Measurements in Potassium*

R. L. Thomas and G. Turner
*Department of Physics, Wayne State University, Detroit, Michigan*

(Received 31 July 1968)
46.4
p. 768

A precision value of the de Haas–van Alphen (dHvA) frequency for single crystals of potassium has been obtained. Free-standing samples of known orientation were used to avoid the errors from differential thermal contraction inherent in measurements on encapsulated samples. The oscillations of magnetization were measured using a small Bi magnetoresistive probe with a modulation technique. Accurate field measurements were made by monitoring the $Cl^{35}$ NMR in a NaCl crystal positioned close to the sample in a highly uniform region of the magnetic field. After suitable corrections for the small anisotropy, we obtain the value $F_0=(1.8246\pm0.0006)\times10^8$ G for the dHvA frequency of an equivalent spherical Fermi surface. This value is significantly lower than the free-electron prediction of $F_0=1.832\times10^8$ G, but not by the full 0.8% predicted by Overhauser on the basis of a charge-density-wave (CDW) ground state. However, the lattice constant (5.225±0.002 Å) used in making the theoretical predictions may be in error. A careful redetermination of its low-temperature value would allow a more meaningful test of the CDW theory. Until such a direct measurement is made, the present experiment may be considered as a determination of the lattice constant of potassium with two possible results: 5.236 Å from free-electron theory, or 5.215 Å if the CDW ground state is valid.

## Electronic Component of Dislocation Drag in Metals

G. P. Huffman and N. Louat
*Edgar C. Bain Laboratory For Fundamental Research, United States Steel Corporation, Research Center, Monroeville, Pennsylvania 15146*

43.4
45.3
46.3
(Received 14 June 1968)
p. 773

The energy dissipation produced by the electric fields and currents associated with a dislocation moving through a metal is calculated from the Boltzmann equation. The applied stress required for steady motion is found to be proportional to the dislocation velocity divided by the electrical resistivity, in good agreement with low-temperature yield- and flow-stress measurements on bcc metals. The forms of the electric fields and currents are derived, and these are found to exhibit Friedel oscillations and to depend in a unique way on the dislocation velocity. The displacement field of a dislocation is believed to be significantly wider and more gradual in an fcc than in a bcc lattice, and this feature can be taken into account either by (1) inserting dislocation widths into the calculation, or (2) assuming perfect electronic screening of the dislocation deformation potential. The stress or drag coefficient obtained from the width calculation shows a very small temperature dependence, while the perfect-screening result is temperature-independent. The problem of a dislocation moving in a magnetic field applied along its length and perpendicular to its direction of motion is also considered. Under suitable conditions, it is found that oscillatory effects of the cyclotron-resonance type may occur in the stress or drag coefficients.

## Inelastic Scattering of Neutrons by Polycrystals*

F. W. de Wette
*Department of Physics, University of Texas, Austin, Texas 78712*
and
Aneesur Rahman
*Argonne National Laboratory, Argonne, Illinois 60439*

(Received 8 May 1968)
42.3
p. 784

A first-principle calculation of the one-phonon, coherent, polycrystalline, inelastic scattering cross section for neutrons has been carried out for a monatomic fcc crystal; the quasiharmonic force constants were obtained from a Lennard-Jones (6–12) potential of interaction between the particles. The calculations were made for three values of the crystal density. The prescription of Egelstaff for calculating this cross section is found to be inadequate, and the formula of Marshall and Stuart is shown to be identical with that of Egelstaff.

## Specific Heat below 3°K of Silver-Gold Alloys

Douglas L. Martin
*Division of Pure Physics, National Research Council of Canada, Ottawa, Canada*

43.5
46.4
46.6
(Received 22 July 1968)
p. 790

The electronic specific heats of Ag-Au alloys for all compositions are slightly less than those calculated by a linear interpolation between the electronic specific heats of the pure components, the maximum difference being about 3%. The theories of Stern and of Haga claim, respectively, that this difference is the result of electron-impurity and electron-phonon interactions. The results fit Stern's relation rather well. An important outcome of this work was the discovery of a significant nuclear specific term in these nonmagnetic cubic alloys. This term has been attributed to electric field gradients, resulting from the random distribution of the two components on the lattice, interacting with the nuclear electric quadrupole moment of gold. The maximum value of this term (~1.4 μcal °K/g-at. *gold*) is observed for an equiatomic alloy. The Debye temperatures of the alloys are slightly higher than those given by a linear interpolation between the two components, the maximum difference being about 2½%.

## Electromigration in Zinc Single Crystals*

J. L. Routbort†
*Department of Physics and Astronomy, Rensselaer Polytechnic Institute, Troy, New York 12181*

43.1
43.4
46.2
(Received 24 July 1968)
p. 796

The electromigration of high-purity Zn single crystals resistively heated in an argon atmosphere has been measured by the marker-motion technique in the temperature range of 360 to 395°C with current densities of ~$5\times10^3$ A/cm². The cylindrical specimens were selected with *c* axes oriented within 25° perpendicular

is found to be proportional to the dislocation velocity divided by the electrical resistivity, in good agreement with low-temperature yield- and flow-stress measurements on bcc metals. The forms of the electric fields and

The electromigration of high-purity Zn single crystals resistively heated in an argon atmosphere has been measured by the marker-motion technique in the temperature range of 360 to 395°C with current densities of $\sim 5\times 10^3$ A/cm². The cylindrical specimens were selected with $c$ axes oriented within 25° perpendicular



or parallel to the direction of current flow. Accurate measurements of both longitudinal and transverse strain rates were used to calculate the anode-directed atom-drift velocity $v_a$, and hence the effective charge on the moving ion, $Z^*$. The effective charge is found to be anisotropic: $Z_{11}^*/f = -2.55\pm 0.15$ and $Z_\perp^*/f = -5.6\pm 0.4$, where $f$ is the correlation factor, which has been shown to be approximately 0.78. The anisotropy of the ion velocities is in the opposite sense and is greater than the anisotropy of the diffusivities. This results from the large anisotropy of the effective charge due to the band structure. It appears that this is the first demonstration of the crystalline anisotropy of the electromigration driving force.

## Fermi Surface of Potassium as Measured by Helicon Doppler-Shifted Cyclotron Resonance

P. A. Penz and Toshinoto Kushida
*Scientific Laboratory, Ford Motor Company, Dearborn, Michigan*

45.4
46.4
(Received 23 May 1968)
p. 804

Accurate helicon measurements of the surface-impedance anomaly associated with Doppler-shifted cyclotron resonance have been made on single-crystal potassium and sodium. The experiment tests the theory of the surface impedance near cyclotron resonance and also assists in the resolution of the charge-density-wave controversy. The influence of surface scattering and sample purity have been determined and found to be in substantial agreement with the surface-impedance theory. The theoretical and experimental line shapes do not agree precisely. The position of the surface-impedance anomaly can be related to the radius of the Fermi surface. Our measurements show that the experimental position does not agree with the free-electron theory in potassium. The charge-density-wave prediction provides a much better fit. In sodium, the experiment fits the free-electron prediction more closely than the charge-density-wave calculation.

## Stage-III Annealing in Gold after Electron Irradiation*

C. Lee† and J. S. Koehler
*Department of Physics and Materials Research Laboratory, University of Illinois, Urbana, Illinois*

43.1
43.2
46.3
(Received 13 June 1968)
p. 813

Gold specimens of nominal 99.9999% purity were irradiated with 3-MeV electrons near liquid-nitrogen temperature. The damage production rate is found to depend on the purity of the specimen giving a lower value for the high-purity specimens. It is also found that the production rate is reduced remarkably by quenching the specimen before irradiation. For high-purity gold, a single large annealing peak is observed in stage III. The slope-change method and Primak analysis are employed to obtain the activation energy of stage-III annealing. Both methods give $0.85\pm 0.02$ eV for the activation energy in high-purity irradiated specimens. The activation energies for quenched and for quench-plus-irradiated specimens of comparable purity are found to be $0.85\pm 0.03$ and $0.86\pm 0.02$ eV, respectively, agreeing with the value for the irradiated specimens within the experimental error. Somewhat lower values are obtained for specimens of lower purity. Second-order kinetics are obeyed in the main part of the stage-III annealing for the irradiated, quench-plus-irradiated, and quenched specimens. Various models are discussed to explain stage-III annealing. It is concluded that vacancy migration in stage III with interstitial clusters acting as sinks can account for the observed results most satisfactorily in the case of gold.

## Qualitative Temperature and Volume Dependence of the Thermal Expansion Coefficient of Solids*

Duane C. Wallace
*Sandia Laboratory, Albuquerque, New Mexico 87115*

33
42.4
(Received 10 June 1968)
p. 827

A thermodynamic expression is derived whereby the measured zero-pressure thermal expansion coefficient may be corrected to a fixed-volume condition for all temperatures. Experimental data so corrected show that the expansion coefficient at fixed volume is nearly constant for temperatures above the Debye temperature. This behavior is in qualitative agreement with the results of lattice-dynamics calculations.

## Band Model for Bismuth-Antimony Alloys*

Stuart Golin
*Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15213*

43.5
46.4
46.7
(Received 12 June 1968)
p. 830

A simple model is proposed which unites many data on alloys of bismuth containing small amounts of antimony. Contrary to the usual interpretation of these data, we propose a crossing of the conduction and valence bands at $L$ at about 6 at.% antimony (i.e., the *direct* gap, which is responsible for the very small effective masses in bismuth, vanishes at this composition).

## Pseudopotential Calculation of the Thermal Expansion Coefficient of Sodium and Potassium*

Duane C. Wallace
*Sandia Laboratory, Albuquerque, New Mexico 87115*

42.4
46.2
(Received 15 July 1968)
p. 832

The total adiabatic potential is represented by a model based on electrostatic interactions among the ions and conduction electrons, Born-Mayer repulsion between the ions, a local pseudopotential interaction between ion cores and conduction electrons, and conduction-electron kinetic, exchange, and correlation energies. The three model parameters are determined for sodium and potassium by requiring agreement with the crystal binding energy and its first two volume derivatives at zero temperature and pressure. The phonon frequencies and Grüneisen parameters, the bulk-modulus pressure derivative, and the thermal expansion coefficient as a function of temperature are then calculated. These calculations are in good qualitative agreement with experimental results.

## Elastic and Thermal Waves in Solids at Hypersonic Frequencies

Helmut D. Weymann*
*Department of Physics and Astronomy and Institute for Fluid Dynamics and Applied Mathematics, University of Maryland, College Park, Maryland 20742*

45.1
45.2
(Received 23 May 1968)
p. 838

A unified phenomenological description of the propagation of elastic and thermal waves in dielectrics and metals makes use of frequency-dependent transport coefficients for thermal conduction and viscosity. The results of this theory contain as limiting cases the different theoretical and experimental findings reported in the literature.

## Determination of the Number of Unique Configurations of Unrelaxed Clusters in Crystal Lattices*

A. P. Brody and M. Meshii
*Department of Materials Science and Materials Research Center, Northwestern University, Evanston, Illinois*
43.1 43.3 46.3
(Received 1 July 1968)
p. 845

A procedure, applicable for use on a computer, is presented which permits the determination of the number and arrangement of unique $n$-component unrelaxed clusters for cubic lattices in $x$-$y$-$z$ space. The configurations thus obtained are listed for the fcc, bcc, and simple-cubic lattices. The present results apply to clusters which are composed of either vacancies and/or substitutional impurities.

## Positron Annihilation in Yttrium and Zirconium*

R. P. Gupta
*Institute for Atomic Research and Department of Physics, Iowa State University, Ames, Iowa 50010*
and
T. L. Loucks†
*Science Center, North American Rockwell Corporation, Thousand Oaks, California 91360*
25 44.1 46.4
(Received 8 August 1968)
p. 848

The angular dependence of the positron annihilation radiation along the [0001] direction has been studied in yttrium and zirconium by the augmented-plane-wave method. The calculation was performed using a mesh of 250 points distributed uniformly throughout the 1/24 zone. A set of 32 reciprocal lattice vectors was used to determine the eigenvalues and eigenfunctions. Exchange was treated in the Slater's $\rho^{1/3}$ approximation. The calculated curve for yttrium shows a fairly good agreement with the experimental results of Williams and Mackintosh. The theory predicts a more pronounced hump in the curve near the zone boundary than is observed experimentally. The experimental data for zirconium are not available, but the calculation shows that the hump almost disappears as the $d$ shell starts filling in.

## High-Temperature Recovery of Tungsten after Neutron Irradiation*

L. K. Keys, J. P. Smith, and J. Moteff
*Nuclear Systems Programs, General Electric Company, Cincinnati, Ohio 45215*
43.2 43.4 46.3
(Received 16 May 1968)
p. 851

The recovery of neutron-irradiation-induced defects in tungsten has been investigated via isochronal resistivity studies after irradiations from $8.5\times10^{17}$ to $1.5\times10^{21}$ $n$ cm$^{-2}$ ($E_n>1$ MeV). These studies have shown that after irradiation at reactor ambient temperature (~70°C), recovery occurs in three principal recovery regions. The first region (stage III) occurs between 100 and 450°C, the second between 450 and 650°C, and the third (stage IV) between 650 and 1000°C. The temperature of maximum recovery of the stage-III region decreased from 360 to 270°C with increasing fluence. The temperature of the maximum recovery of the second region also appears to decrease slightly with increasing fluence. The temperature of maximum recovery of stage IV is independent of the neutron fluence over the fluence range utilized in this investigation. A residual resistivity, remaining after completion of the isochronal anneals, shows a linear (slope of 1) dependence on the thermal-neutron fluence. This is believed due to the formation of rhenium, as a result of thermal-neutron $(n,\gamma)$ reactions in tungsten. The shifts of the peak temperatures of the lower-temperature recovery regions are believed to result primarily from the weakening of the lattice by rhenium at low temperatures and high thermal-neutron fluences. The shift of the stage-III recovery region may also contain effects due to interactions between overlapping damage regions. Above about $10^{20}$ $n$ cm$^{-2}$ ($E_n>1$ MeV), a deviation from a linear dependence of the log of the resistivity on the log of the fast neutron fluence supports the approach of saturation.

## Size Effect in the Electrical Conductivity of Cylindrical Wires

H. J. Mackey, W. D. Deering, and J. R. Sybert
*Department of Physics, North Texas State University, Denton, Texas 76203*
42.2 45.4
(Received 25 July 1968)
p. 856

Magnetomorphic oscillations in the isothermal electrical conductivity are examined for the case of cylindrical wires (infinitely long with radius $r$). The theory assumes a spherical Fermi surface and diffuse scattering of the electrons at the boundaries of the sample. The magnetic field is taken normal to the axis of the cylinder. The magnetomorphic oscillatory component of the electrical conductivity, periodic in magnetic field, becomes significant when the mean free path is the same order of magnitude as the radius of the cylindrical sample. Expressions are obtained for the magnetomorphic oscillatory components $\delta_{ij}$ of the elements of the electrical conductivity tensor $\sigma_{ij}$. The period of the oscillations, $P_0=\pi\hbar p_F c/er$, is the same as that of thin plate geometry (H normal to the plate) with the diameter of the cylinder equal to the plate thickness, and affords a direct measure of the Fermi radius $p_F$. The amplitude of the oscillations in the $\delta_{ij}$ falls off with magnetic field as $H^{-3/2}$, in contrast to the $H^{-1}$ dependence for thin films.

## Anomalous Size Effects in the Galvanomagnetic Properties of Zinc Caused by Compensation*

Stephen B. Soffer
*Department of Physics, Polytechnic Institute of Brooklyn, Brooklyn, New York 11201*
42.2 45.4 46.5
(Received 3 July 1968)
p. 861

Galvanomagnetic measurements have been made at 4.2°K on thin zinc crystal samples, with the thin dimension parallel to the $c$ axis. Different thicknesses in the range 70–400 $\mu$ were produced by electropolishing. The magnetic field $H$ was varied between 0 and 14 kG. The longitudinal magnetoresistivity ($\rho_{11}$) generally shows no unusual thickness dependence. However, the transverse magnetoresistivity with the field perpendicular to the broad face ($\rho_{\perp}$) and the Hall resistivity ($\rho_{21}$) show anomalous thickness dependences. At higher fields, $\rho_{\perp}$ at a given $H$ consistently decreases with diminishing thickness (negative size effect) and obeys an $H^n$ law, with $n$ nearly 2, at a given thickness. $\rho_{21}$ shows oscillations, probably magnetomorphic, which are superimposed on a gross Hall resistivity which is approximately proportional to $H$ at higher fields. The gross Hall coefficient $R$ increases rapidly from the thinnest to next thickest sample, then decreases with increasing thickness, becoming slightly negative near 400 $\mu$. Sondheimer's size-effect model was extended to a multiparabolic band conductor and evaluated at high fields for both compensated and uncompensated conductors. More general band models are discussed briefly. For a compensated conductor, the parabolic model predicts an inversion of the usual thickness dependence of $\rho_{\perp}$ and a maximum in the magnitude of $R$. The data are in qualitative agreement with these predictions. Physically, these effects are attributed to the interruption by the surface of the carrier trajectories, which prevents the cancellation effects between hole and electron carriers which normally occur at high fields in a compensated conductor. Other measurements in compensated materials are discussed briefly in light of these findings.

of maximum recovery of stage IV is independent of the neutron fluence over the fluence range utilized in this investigation. A residual resistivity, remaining after completion of the isochronal anneals, shows a linear

and electron carriers which normally occur at high fields in a compensated conductor. Other measurements in compensated materials are discussed briefly in light of these findings.



## Thermal and Electrical Conductivities of Very-High-Purity Indium*

M. E. DE LA CRUZ, F. DE LA CRUZ,† J. M. COTIGNOLA,‡ O. J. BRESSAN, AND C. A. LUENGO
*Centro Atómico Bariloche, Comisión Nacional de Energía Atómica San Carlos de Bariloche, Río Negro, República Argentina*
(Received 12 June 1968)
46.5 p. 871

Measurements of the thermal and electrical conductivities of a polycrystalline indium sample of very high purity have been performed between 1.5 and 4.2°K and in the presence of longitudinal magnetic fields up to 15 000 Oe. It was found that, within the experimental error, the electrical and thermal Kohler's rules were satisfied, the functional forms for the two being quite similar. The expression for the resistivity as a function of $T$ for the normal state and in zero magnetic field are in good agreement with theory. The Lorenz number obtained by extrapolating to $T=0$ gives a very high value compared with the theoretical one. Measurements of the thermal conductivity for the superconducting state, in the same temperature range, have been made. The thermal-resistivity ratio $W_n/W_s$ as a function of the reduced temperature does not agree with the results of Kadanoff and Martin.

## Phonon-Assisted Impurity Scattering in Gold Alloys*

D. H. DAMON, M. P. MATHUR, AND P. G. KLEMENS†
*Westinghouse Research Laboratories, Pittsburgh, Pennsylvania 15235*
43.3 46.3 46.5 (Received 25 September 1967; revised manuscript received 5 February 1968) p. 876

Measurements of the electrical resistivity of a number of gold alloys containing Pt, Cu, and In solutes were made between 1.5 and 40°K. Below 20°K the difference between the measured resistivity and the value predicted by Matthiessen's rule is separated into two components, one associated with the "two-band effect" and one associated with phonon-assisted impurity scattering. Above 20°K, only the two-band effect seems to be important. The two-band effect is analyzed in the manner of Dugdale and Basinski; it is smaller in these gold alloys than in their copper and silver alloys. It is shown theoretically that the strength of the phonon-assisted impurity scattering depends on the departure of the conduction-electron wave functions from free-electron-like behavior and on the distortion of the impurity potential by the phonons. The absence of this scattering at high temperature is attributed to the destruction of the temporal coherence of the electron states by the electron-phonon interaction. The ideal resistivity of gold is tabulated from 10 to 500°K.

## Optical Properties of Free-Electron-Like Foils

R. J. ESPOSITO
*Pitman-Dunn Laboratories, Frankford Arsenal, Philadelphia, Pennsylvania 19137*
AND
PHILIP E. BLOOMFIELD
*University of Pennsylvania, Philadelphia, Pennsylvania 19104*
AND
L. MULDAWER
*Temple University, Philadelphia, Pennsylvania 19122*
42.2 44.3 45.3 (Received 24 June 1968) p. 886

The dielectric response of a noninteracting electron gas contained within a thin foil of thickness $D$ has been calculated in the long-wavelength limit for long-mean-free-path electrons undergoing specular reflection at the boundaries. Sinusoidal wave functions are employed to account properly for the boundary conditions. The longitudinal response to $p$-polarized light leads to an absorbing power which is an approximate superposition of the ordinary Drude contribution, proportional to $\tau^{-1}$, and a collisionless contribution, proportional to $D^{-1}$. The thickness-dependent conductivity is predicted to be of the same order of magnitude as the bulk experimental conductivity of the alkali metals at low temperature in the near infrared spectral region for foils with $D \gtrsim 300$ Å. This contribution should also be detectable from optical polarization studies on $n$-doped semiconductor foils, but appears to be masked by the Drude background for other free-electron-like films.

## Band-Structure Effects and Many-Particle Scattering Corrections in the Far-Ultraviolet Spectra of Ge and Si

DAVID BRUST*
*Department of Physics, Northwestern University, Evanston, Illinois*
AND
EVAN O. KANE
*Bell Telephone Laboratory, Murray Hill, New Jersey*
44.1 44.3 47.4 (Received 15 July 1968) p. 894

The band structures of Ge and Si are computed to account for electron and hole states far from the forbidden gap. A Born approximation is employed to compute the contributions of electron-phonon and electron-electron scattering to the imaginary part of the self-energy function. The electron and hole spectral weight functions are evaluated, and the effects of the self-energy function on $\epsilon_2(\omega)$ determined. Our computed dielectric function seems in excellent accord with the recent work of Marton and Toots in the far ultraviolet (5–10 eV).

## Electron Mobility in CdS at High Electric Fields*

K. W. BÖER AND K. BOGUS†
*Physics Department, University of Delaware, Newark, Delaware 19711*
(Received 20 May 1968)
47.5 p. 899

The Hall mobility of electrons in CdS platelets has been measured at 230°K as a function of the electric field using stationary cathode-adjacent high-field domains in the range of negative differential conductivity. The electron mobility is observed to be field-independent up to 30 kV/cm. Above 30 kV/cm it decreases linearly with the field from its low-field value of about 620 cm²/V sec, to about 300 cm²/V sec at 70 kV/cm, indicating scattering of hot electrons with optical phonons.

## X-Ray Determination of the Electron Momentum Density in Diamond, Graphite, and Carbon Black

RICHARD J. WEISS
*Materials Research Laboratory, Army Materials and Mechanics Research Center, Watertown, Massachusetts 02172*
AND
WALTER C. PHILLIPS
*National Aeronautics and Space Administration Electronics Research Center, Cambridge, Massachusetts 02139*

46.4
47.4
(Received 3 July 1968)
p. 900

The Compton profile has been measured with the x-ray scattering vector along five selected crystallographic directions in diamond, in polycrystalline diamond, in carbon black, and with the x-ray scattering vector along three selected directions in pyrolytic graphite. The electron momentum densities in both diamond and graphite are more extended in momentum space than a superposition of Hartree-Fock $1s^2 2s 2p^3$ free-atom momentum densities, with the diamond momentum density more extended than the graphite. The momentum densities of carbon black and graphite are similar, as expected from an earlier x-ray diffraction investigation of their crystal structures. The small anisotropies found in the diamond momentum density can be qualitatively explained by assuming that some momentum density at high momentum values in momentum space has been transferred from the ⟨211⟩ directions to the ⟨100⟩ directions. The small anisotropy measured in graphite is in marked contrast to the large anisotropy found in positron-annihilation measurements. In addition, the momentum density of graphite deduced from positron annihilation is less extended in momentum space than that deduced from the x-ray measurements. As suggested by Berko, these results give insight into the positron wave function and its perturbation of the annihilated electron. In diamond, the momentum densities deduced from positron annihilation and the Compton profile are similar.

## Electroreflectance Measurements on $Mg_2Si$, $Mg_2Ge$, and $Mg_2Sn$†

F. VAZQUEZ,* RICHARD A. FORMAN,‡ AND MANUEL CARDONA§
*Department of Physics, Brown University, Providence, Rhode Island 02912*

(Received 1 July 1968)
47.4
p. 905

The room-temperature electroreflectance spectra of the II–VI compounds $Mg_2Si$, $Mg_2Ge$, and $Mg_2Sn$ are reported in the energy region 1.5–4.5 eV. All measurements were performed using the electrolyte technique with a nonaqueous electrolyte. These materials crystallize with the antifluorite crystal structure and are small-band-gap semiconductors. In all of the materials, a large number of sharp peaks were observed; the spectra are interpreted in terms of the reflectivity spectra and existing energy-band calculations. Special mention should be made of a doublet observed (1.64–1.84 eV) in the spectrum of $Mg_2Ge$. This doublet appears to be due to the spin-orbit splitting of the $\Gamma_{15}$ valence band.

## Magnon Corrections to the Effective Mass of an Electron in a Magnetic Semiconductor*

ROBERT M. WHITE AND ROY B. WOOLSEY†
*Department of Physics, Stanford University, Stanford, California 94305*

47.1
47.5
49.5
(Received 18 July 1968)
p. 908

We have computed the renormalization of the conduction-electron energy in a degenerate ferromagnetic semiconductor at zero temperature due to the virtual emission and reabsorption of spin waves. We find that as a result of the difference between the up- and down-spin Fermi momenta, this renormalization is quite small. However, in the case where the conduction electrons are antiferromagnetically coupled to the ionic moments, it is possible by doping to achieve a situation in which the effective mass of the down-spin electrons is increased by about 30%, while the up-spin electrons remain unaffected.

## Electron and Phonon Tunneling Spectroscopy in Metal-Germanium Contacts*

F. STEINRISSER AND L. C. DAVIS†
*Department of Physics and Coordinated Science Laboratory, University of Illinois, Urbana, Illinois*
AND
C. B. DUKE
*General Electric Research and Development Center, Schenectady, New York*

42.2
45.3
47.2
(Received 21 June 1968)
p. 912

Measurements of the tunneling characteristics of metal electrodes on vacuum-cleaved Sb-doped Ge reveal greatly improved agreement with the one-electron model relative to chemically fabricated units. Strong phonon-assisted tunneling in both Sb- and As-doped Ge is observed, and is interpreted in terms of a two-step process via an evanescent state at $\Gamma_2'$. The tunneling characteristics at $eV \cong \pm\hbar\omega_{LO}$ in Ga-doped Ge are interpreted in terms of the alternation of the electronic dispersion relation due to deformation-potential coupling between the holes and the LO phonons.

## Spin Splitting and the Ultraviolet Absorption of Ge*

LUIS R. SARAVIA AND DAVID BRUST
*Department of Physics, Northwestern University, Evanston, Illinois 60201*

44.1
44.3
47.4
(Received 24 June 1968)
p. 915

The spin-split energy bands of germanium are computed throughout the entire Brillouin zone. A combined orthogonalized-plane-wave and pseudopotential approach is employed. A parametrization for the spin is given which we believe to be accurate to about 10% for both the valence and the conduction band, and which includes most of the $2p$-$3p$ core interference effects. A highly refined zone sampling is used to get the fine details of the optical spectrum. The resulting line shape is excellent for the 2.1–2.3-eV doublet. The structure near 5.0 eV is much improved over the spin-free results. In addition, a new, but quite weak, multiplet is found near 3 eV and is associated with the $\Gamma_{25'} \rightarrow \Gamma_{15}$ transitions.

## Calculation of Ionized-Impurity Scattering Mobility of Electrons in $Hg_{1-x}Cd_xTe$†

DONALD LONG
*Honeywell Corporate Research Center, Hopkins, Minnesota 55343*

43.3
47.3
47.5
(Received 19 July 1968)
p. 923

A study is made of the magnitude of the ionized-impurity scattering mobility of conduction electrons in $n$-type $Hg_{1-x}Cd_xTe$ at 4.2°K, covering the alloy composition range $0 < x < 0.3$. Calculations of the mobility have been made, assuming the Born approximation for scattering by singly ionized donors in degenerate material having a nonparabolic conduction band. They account well for available mobility data.

semiconductor at zero temperature due to the virtual emission and reabsorption of spin waves. We find that as a result of the difference between the up- and down-spin Fermi momenta, this renormalization is quite

in $n$-type $Hg_{1-x}Cd_xTe$ at 4.2°K, covering the alloy composition range $0<x<0.3$. Calculations of the mobility have been made, assuming the Born approximation for scattering by singly ionized donors in degenerate material having a nonparabolic conduction band. They account well for available mobility data.



## Electron-Capture ("Internal") Luminescence from the Oxygen Donor in Gallium Phosphide

P. J. Dean and C. H. Henry
*Bell Telephone Laboratories, Murray Hill, New Jersey*

43.3 44.3 47.3
(Received 2 July 1968)
p. 928

We report the infrared radiative capture of electrons at ionized oxygen donors in gallium phosphide. The radiative transition occurs between a shallow excited state (ionization energy 51.5±2 meV) and the deep $1s(A_1)$ ground state (ionization energy 893±2 meV) of the donor. The uniaxial stress dependence of this transition suggests that the excited state is the doublet $1s(E)$. The luminescence is predominantly due to phonon-assisted transitions. Appreciable fine structure has been resolved in the vibronic sideband. Some of this structure involves phonons characteristic of pure gallium phosphide, but strong replicas associated with in-band-resonance modes of the oxygen impurity atom are also seen. The energies of the local modes are appreciably reduced when $O^{16}$ is replaced by $O^{18}$. In addition, the no-phonon transition energy decreases slightly by an amount anticipated from the no-phonon shift of donor-acceptor pair spectra involving the oxygen donor. The oxygen electron-capture luminescence is quenched in crystals containing $\gtrsim 5\times10^{16}$ cm$^{-3}$ neutral acceptors and does not saturate as rapidly as the donor-acceptor pair luminescence. Two Auger transitions are suggested to account for these properties. Weak absorption lines due to no-phonon and phonon-assisted interbound-state excitations within the oxygen donor have been detected through measurements of the excitation spectrum of the oxygen luminescence in $n$-type crystasl. A tentative assignment of the principal no-phonon absorption lines is given.

## Donor-Acceptor Pair Recombination Involving the First Excited State of a Donor in GaAs

Jagdeep Shah, R. C. C. Leite, and J. P. Gordon
*Bell Telephone Laboratories, Holmdel, New Jersey 07733*

43.3 44.3 47.3
(Received 9 August 1968)
p. 938

The photoluminescence spectrum of epitaxially grown $n$-type GaAs in the vicinity of the band-gap energy shows peaks whose temperature dependence and energy separations suggest the existence of pair recombination radiation involving the ground state and first excited state of a donor. Calculation based on this model and the use of hydrogenic wave functions for the ground state and the first excited state of the donor indicate that the recombination radiation arises from donor-acceptor pairs whose most probable separation is about 420 Å. This number is in reasonable agreement with the expectation based on the measured room-temperature conductivity of the sample.

## Band Inversion and the Electrical Properties of $Pb_xSn_{1-x}Te$†

J. R. Dixon and R. F. Bis
*U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland 20910*
*and*
*University of Maryland, College Park, Maryland 20742*

47.4 47.5
(Received 26 July 1968)
p. 942

The electrical resistivity and Hall coefficient of $Pb_xSn_{1-x}Te$ alloys were determined as a function of temperature from 4 to 300°K. The measurements were intended as a test of Dimmock, Melngailis, and Strauss's band-inversion model in the immediate region of band crossing. The resistivity is characterized by a predominantly linear dependence upon $T$, and by the distinct breaks which occur in this dependence. The linearity is attributed to degenerate lattice scattering. The temperatures at which the breaks occur depend upon alloy composition, and are relatively independent of carrier concentration and carrier mobility. These break temperatures are in excellent agreement with band-crossing temperatures predicted on the basis of the band-inversion model. This fact, along with several other features of the results, strongly supports the band-inversion model.

## Thermoreflectance in Semiconductors*

E. Matatagui,† A. G. Thompson, and Manuel Cardona‡
*Physics Department, Brown University, Providence, Rhode Island 02912*

44.3 44.4 47.4
(Received 25 June 1968)
p. 950

The thermoreflectance spectra of Si, AlSb, GaP, GaAs, GaSb, InP, InAs, InSb, ZnO, ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe, HgSe, and HgTe are reported. Measurements were made on most materials at both room and liquid-nitrogen temperatures. The positions of the peaks observed are compared with previous reflectance and electroreflectance data. Some representative spectra were subjected to a Kramers-Kronig analysis, and the changes in the real and imaginary parts of the dielectric constant, induced by the change in temperature of the sample, were obtained. The resulting line shapes are compared with those derived from elementary theory. In order to achieve reasonable agreement between theory and experiment, it is found necessary to invoke the presence of excitons at all the interband edges. It is demonstrated that, under certain conditions, the type of critical point involved in the transition can be identified.

## Isoelectronic Oxygen Trap in ZnTe

J. L. Merz
*Bell Telephone Laboratories, Murray Hill, New Jersey*

43.3 47.3 47.4
(Received 18 July 1968)
p. 961

An optical transition at 1.986 eV in ZnTe has earlier been attributed to the radiative recombination of an electron-hole pair bound at an oxygen atom substituting isoelectronically for Te. In this paper the results of isotopic substitution and Zeeman experiments are offered to prove the correctness of this identification. Crystals of ZnTe grown in the presence of $ZnO^{18}$ exhibit an isotope shift of the $B(J=2)$ line 0.45±0.05 meV to higher energies. At 1.7°K, this is observed both for the no-phonon line and its LO phonon replicas. Zeeman analysis of the $J=2$ quintet shows that the impurity center has the cubic symmetry of the ZnTe zinc-blende lattice, and is therefore a point defect. The dominant character of the $B$-line emission is found to be forced electric dipole, produced by the magnetic field mixing of $B(J=2)$ and $A(J=1)$ states.

## Theory of the Tunneling Spectroscopy of Collective Excitations

Alan J. Bennett, C. B. Duke, and S. D. Silverstein
*General Electric Research and Development Center, Schenectady, New York 12301*

41.1 42.2 45.3
(Received 10 June 1968)
p. 969

The transfer-Hamiltonian model of a tunnel junction is extended to incorporate the interaction of a tunneling electron with impurities and collective excitations in the barrier region. The associated elastic and inelastic contributions to the tunnel current are evaluated, and are compared with the consequences of (bulk) electron-collective-mode coupling in the conducting electrode. Expressions for incoherent electron-phonon coupling via potential fluctuations in the barrier and coherent coupling via constituent atoms

of the barrier are derived. Various contributions to both the elastic and inelastic currents due to these coupling mechanisms are classified and evaluated. A prototype square-barrier model, which simulates the potential metal-semiconductor, metal-oxide-metal, or direct $p$-$n$ tunnel junctions, is used to described the "one-electron" aspects of the tunneling characteristics. For a narrow, high barrier at $T=0$, the one-phonon impurity-induced conductance is proportional to $(eV)\Theta(\hbar\omega_D-eV)+(\hbar\omega_D)\Theta(eV-\hbar\omega_D)$, where $\hbar\omega_D$ is the highest phonon energy. The one-phonon constituent-atom-induced conductance under similar conditions is proportional to $(eV)\Theta(\hbar\omega_D-eV)+(\hbar\omega_D)\Theta(eV-\hbar\omega_D)$. The calculated line shape, temperature dependence, carrier-mass dependence, and impurity-density dependence of the impurity-induced inelastic conductance are shown to agree reasonably well with existing experimental data.

## Bound-Exciton, Free-Exciton, Band-Acceptor, Donor-Acceptor, and Auger Recombination in GaAs

E. Hal Bogardus* and H. Barry Bebb

*Texas Instruments Incorporated, Dallas, Texas 75222*

44.3
47.4

(Received 18 March 1968; revised manuscript received 3 July 1968)

p. 993

The broad-band photoluminescence spectra typical of bulk-grown or low-purity epitaxial GaAs breaks into a number of sharp emission lines in very-high-purity GaAs. At low temperatures (~2°K), emission peaks due to free excitons (1.5156 eV), excitons bound to neutral (1.5145 eV) and ionized (1.5133 eV) donors, and excitons bound to neutral (1.5125 eV) and ionized (1,4886 eV) acceptors are identified. Also, band-acceptor (1.4926 eV) and donor-acceptor (1.4857 eV) recombination is observed. The assignments are based on dependence of the emission lines with temperature, impurity content, and carrier type ($n$- or $p$-type material), as well as on the relative energy positions. The temperature dependence of the exciton–neutral-donor complex appears to be influenced by nonradiative Auger recombination.

## Hall Measurements in Liquid Thallium-Tellurium*

James M. Donally and Melvin Cutler

*Physics Department, Oregon State University, Corvallis, Oregon*

32.4
45.4
47.5

(Received 22 July 1968)

p. 1003

Hall measurements are reported for compositions of Tl-Te between 31 and 60 at.% thallium and in the temperature range 340–640°C. The sign of the Hall coefficient is negative in spite of the fact that the Seebeck coefficient is positive. The Hall mobility does not change appreciably with temperature, and its magnitude seems to vary linearly with composition in the range 0–60 at.% thallium. The magnitude of the Hall mobility (0.3–0.5 cm²/V sec) and its small temperature coefficient is very similar to that observed in chalcogenide glasses, where the same sign discrepancy has been observed.

## Vibrations of Disordered Solids

Herbert B. Rosenstock and Richard E. McGill

*U. S. Naval Research Laboratory, Washington, D. C. 20390*

42.3
43.3
43.5

(Received 22 July 1968)

p. 1004

An important portion of the vibrational spectrum of an infinite disordered solid is attributed to "localized" vibrations. These can be investigated in detail through the study of the vibrations of very small solids: It is argued that any vibrational mode found in a small solid that has the property that atomic amplitudes are very small near the boundary will also be found, with at most slight perturbation, in a large solid. It is observed that such modes appear whenever a group containing light atoms occurs and is bounded by a sufficient number of heavy atoms; the number that is "sufficient" depends somewhat on force model, mass ratio, and dimensionality, but is generally small. The density of these local modes in the spectrum of the large crystal can then be computed from the probability of the occurrence in the large crystal of the configuration of masses that produces it. For the case of the one-dimensional binary alloy, the major features of the earlier direct numerical computation (Dean) can be reproduced and understood by this simple method. Similar features (peaks) are predicted for two- and three-dimensional structures, but their intensity compared to the continuous part of the spectrum is shown to be smaller.

## Ion-Size Effects in Color Centers

R. H. Bartram* and A. M. Stoneham

*Theoretical Physics Division, Atomic Energy Research Establishment, Harwell, Berkshire, England*

and

Philip Gash†

*Physics Department, University of Connecticut, Storrs, Connecticut 06268*

48.7

(Received 29 July 1968)

p. 1014

A modification of the point-ion model is proposed which provides an approximate correction for ion-size effects. The difference between the optimum pseudopotential for the smoothest pseudo-wave-function and the point-ion potential is treated as an ion-size correction to the Hamiltonian, appropriate to a smooth variational trial function. By neglecting the variation of the trial function over the ion cores in the evaluation of matrix elements, one obtains a simple, approximate form for the pseudopotential: $V_p=V_{PI}+\Sigma_\gamma[A_\gamma+(\bar{V}-U_\gamma)B_\gamma]\delta(\mathbf{r}-\mathbf{r}_\gamma)$, where $V_{PI}$ is the point-ion potential, $U_\gamma$ is the potential at ion $\gamma$ due to the other ions, and $\bar{V}$ is the average potential. The coefficients $A_\gamma$ and $B_\gamma$ are properties of the ions alone, and have been computed for a large set of ions. The approximate pseudopotential is applied to the calculation of ionization potentials of alkali atoms, where it works well, and of $F$-band energies in alkali halides and alkaline-earth fluorides, where it is found that all of the coefficients $A_\gamma$ must be reduced by a factor of 0.53 in order to obtain agreement with experiment. With the adjusted pseudopotential coefficients, the theory accounts well not only for the Ivey law in alkali halides, but also for deviations from the Ivey law. In addition, the seemingly anomalous $F$-band energy in $BaF_2$ is accounted for. The empirically adjusted constants may be useful in other color-center problems as well.

## ESR Studies of Radiation-Damage Centers in Barium Sulfide*

James L. Kolopus

*Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

and

Gerald J. Lapeyre

*Department of Physics, Montana State University, Bozeman, Montana 59715*

43.2
48.7

(Received 8 July 1968)

p. 1025

Single crystals of BaS have been grown and irradiated with neutrons, producing an intense $F$-center spectrum with a spectroscopic splitting factor, $g=1.9637\pm0.0005$. The isotropic part of the hyperfine interaction $A$ is $41.0\pm0.2$ and $36.4\pm0.2$ G for the nearest-neighbor $^{137}$Ba and $^{135}$Ba nuclei, respectively. The dipolar hyperfine interaction constants $B$ are found to be $4.0\pm0.1$ and $3.8\pm0.1$ G, respectively, for the same nuclei. $F$ centers were also observed in samples which had been crushed or $\gamma$-irradiated following deformation. Other damage centers were observed with less intensity than the $F$ center and are briefly discussed.

vibrations. These can be investigated in detail through the study of the vibrations of very small solids: It is argued that any vibrational mode found in a small solid that has the property that atomic amplitudes are very small near the boundary will also be found, with at most slight perturbation, in a large solid. It is ob-

dipolar hyperfine interaction constants $B$ are found to be $4.0\pm0.1$ and $3.8\pm0.1$ G, respectively, for the same nuclei. $F$ centers were also observed in samples which had been crushed or $\gamma$-irradiated following deformation. Other damage centers were observed with less intensity than the $F$ center and are briefly discussed.



## Hypersonic Attenuation in Rutile*

JAMES N. LANGE
*Department of Physics, Oklahoma State University, Stillwater, Oklahoma 74074*
(Received 14 June 1968)
43.1 45.1 48.5 p. 1030

The low-temperature frequency and temperature dependence of the microwave acoustic attenuation in rutile is determined. In the temperature region where three-phonon interactions dominate the attenuating process, a decided anisotropy and mode dependence is observed in the attenuation of the induced acoustic phonon. Parameters used in the description of the attenuation, such as the phonon lifetimes, should reflect this anisotropy rather than a spatial average. The introduction of low densities of imperfections by vacuum reduction of the rutile has no appreciable effect on the low-temperature frequency and temperature dependence of the attenuation. The phonon interactions leading to the attenuation appear to be homogeneous and reflect the anharmonic components of the crystal potential rather than any microscopic inhomogeneities.

## Ionic Transport in Potassium Chloride

ROBERT G. FULLER, CHARLES L. MARQUARDT, MICHAEL H. REILLY,* AND JOHN C. WELLS, JR.†
*Naval Research Laboratory, Washington, D. C. 20390*
43.4 45.3 48.3 p. 1036

The electrical conductivity and chlorine ion diffusion in KCl and KCl:$SrCl_2$ single crystals have been analyzed by least-squares methods, using as a model a perfect crystal perturbed by five defects: isolated anion vacancies, isolated cation vacancies, divalent cation impurities, divalent cation-impurity–cation-vacancy complexes, and vacancy pairs. The transport equations were derived from this five-defect model using a simple theory for noninteracting particles, except for the nearest-neighbor binding to form complexes and vacancy pairs, and using the same theory including long-range Coulomb interactions between the isolated defects. This latter theory yielded the better description of the experimental results. However, the analyses showed that significant nonrandom deviations exist between theory and experiment. These deviations exist in both the intrinsic and extrinsic regions of conductivity. The failure of existing concepts for these transport properties is discussed in terms of possible additional mechanisms, i.e., electrons, cationic Frenkel defects, or trivacancies, and in terms of more complete theoretical treatment.

## Lattice Thermal Conductivity for a One-Dimensional, Harmonic, Isotopically Disordered Crystal*

KENNETH R. ALLEN
*Department of Physics and Astronomy, University of Florida, Gainesville, Florida 32601*
AND
JOSEPH FORD
*School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332*
42.3 43.3 45.2
(Received 18 December 1967; revised manuscript received 15 July 1968)
p. 1046

A formally exact expression for the Kubo thermal conductivity is obtained for an infinite, one-dimensional chain of atoms which are connected by nearest-neighbor, harmonic springs of equal strength, and which are of equal mass except within a finite section of the chain which contains disordered isotopic impurities. The two infinite, isotopically pure regions are used as high- and low-temperature reservoirs which cause an energy flow through the isotopically disordered region, whose thermal conductivity is calculated. It is found that the Kubo thermal conductivity for this model is always finite. Various approximations which allow explicit evaluation of the conductivity are discussed.

## Paraelectric-Resonance Spectroscopy*

T. L. ESTLE
*Physics Department, Rice University, Houston, Texas 77001*
22 43.1 48.3
(Received 22 May 1968)
p. 1056

A theoretical description of paraelectric resonance is presented and analyzed in sufficient detail for comparison with experimental data on KCl. Some possible models for a paraelectric entity in relatively pure KCl are obtained, all of which can be distinguished from each other by further measurements. The simplest description and the one that fits best is a system of eight ⟨111⟩ dipoles with tunneling energy $\Delta_c$ of 10 GHz (a 21-GHz zero-field splitting) and an uncorrected electric-dipole moment $\mu$ of 7 D. This is consistent with substitutional $Li^+$ ions, but not with $OH^-$ ions, which are known to be six ⟨100⟩ dipoles. Other less prominent structure was not explained by this description.

## Recombination Luminescence from Self-Trapped Excitons in Ammonium Halide Crystals

M. J. MARRONE AND M. N. KABLER
*Naval Research Laboratory, Washington, D. C. 20390*
(Received 12 August 1968)
43.2 48.7 p. 1070

Luminescence due to intrinsic self-trapped exciton annihilation has been observed in ammonium halide single crystals under $x$ irradiation at low temperatures. A broad emission band appears at 4.86 eV for $NH_4Cl$, 4.20 eV for $NH_4Br$, and 3.74 eV for $NH_4I$. The source of the luminescence is identified primarily through an experiment which relates the polarization of the luminescence to the orientation of self-trapped holes or $V_k$ centers. As in the alkali halides, the self-trapped exciton may be characterized as a bound pair of nearest-neighbor halide ions in an excited state. The transition in $NH_4Cl$ is $\sigma$-polarized with respect to the pair axis, and its lifetime under pulsed x-ray excitation is on the order of $10^{-9}$ sec. The $NH_4Br$ emission band consists of two overlapping transitions. There is a fast $\sigma$-polarized component similar to that found in the chloride. The other component is $\pi$-polarized and has a longer lifetime of $7.7\times10^{-7}$ sec. Comparison is made between these transitions and similar transitions previously observed in the alkali halides. It is concluded that the self-trapped exciton states are essentially the same in the two materials; in particular, a triplet state evidently initiates the long-lived emission band.

## ac Dielectric Investigations of the Gyulai-Hartly Effect: Enhanced Conductivity in Alkali Halides following Plastic Deformation*†

M. C. SHINE‡ AND R. K. MACCRONE§
*School of Metallurgy and Materials Science and Laboratory for Research on the Structure of Matter, University of Pennsylvania, Philadelphia, Pennsylvania 19104*
43.4 48.3 48.5
(Received 3 June 1968)
p. 1076

The real and imaginary parts of the dielectric constant of single-crystal specimens of NaCl have been measured as a function of time after plastic compressive strain of about 3%. Measuring frequencies ranged between 1 and 100 kHz and temperature between 20°C and 120°C. Both the real and imaginary part of the dielectric constant pass through a maximum at times after deformation which decrease with increasing

temperature. A detailed kinetic analysis of the increase indicates that second-order kinetics are involved, and that the migrating defect has an activation energy of 0.74±0.01 eV, an energy characteristics of the cation vacancy. A similar kinetic analysis of the decrease indicates that first-order kinetics are involved with an activation energy of 0.64±0.05 eV. A model based on the assumption that isolated impurity $Ca^{++}$ ions and cation vacancies are produced from clusters or precipitates by dislocation motion, and that the increase in the dielectric constant arises from the $Ca^{++}$-cation vacancy dipole formation, while the subsequent migration of the $Ca^{++}$-vacancy dipoles to the dislocations results in the observed decrease in dielectric constant satisfactorily accounts for the major experimental observations. The extrinsic dependence of the effect is verified by analytically extracting the Debye behavior of the $Ca^{++}$-vacancy dipoles. The dielectric properties of old dislocations are shown to consist of a dipolar component of relative displacement of charge cloud and dislocation core and a purely ohmic component of ionic diffusion in the dislocation core.

## Effect of Optical and Thermal Bleaching on the uv Bands in Highly Pure and Mn-Doped KCl Crystals

P. C. Mehendru and Ved Mitra
*National Physical Laboratory, New Delhi, India*

43.2
48.7
(Received 24 June 1968)
p. 1089

In highly pure KCl crystals, x irradiated at room temperature (RT), the usual uv absorption bands at 212 and 230 nm are observed. The peak position of the 212-nm band when bleached with uv light shifts gradually to 195 nm, without any appreciable change in the intensity of this band. On thermal bleaching (in the range RT to 150°C) in the dark, the position and the intensity of the 212-nm band remain unchanged. When bleached thermally or optically with uv light, the peak position of the 230-nm band remains unaltered, whereas its intensity decreases. In uncolored KCl:Mn crystals, Mn introduces two uv absorption bands at 201 and 273 nm, having half-widths 0.36 and 0.15 eV, respectively. On x irradiation, the positions, intensities, and half-widths of these absorption bands remain unaltered, and a new absorption band at 223 nm appears. The intensity and half-width of the 223-nm band increases up to 25 h of x irradiation. Although thermally unstable, the centers responsible for the 223-nm band are fairly resistant to uv-light bleaching. An activation energy $E_a=0.54\pm0.02$ eV is obtained for the thermal bleaching of the centers that absorb in the 223-nm band. Qualitatively, the 223-nm band is similar to the $D$ bands observed by Ishii and Rolfe.

## Effect of Many-Body van der Waals Forces on the Lattice Dynamics of Rare-Gas Crystals

A. A. Lucas*
*Battelle Memorial Institute, Columbus, Ohio 43201*

42.3
48.1
(Received 3 June 1968)
p. 1093

The contribution of the many-body part of the van der Waals forces to the lattice-vibration Hamiltonian of rare-gas crystals is investigated, and the result is compared with the usual two-body lattice potential (a Lennard-Jones potential, for instance). While the static lattice energy is modified only by a few percent, the harmonic term and the successive anharmonicities are so much influenced by collective dispersion forces that their perturbational developments in terms of pair, triplet, etc., contributions are inadequate. In this paper we show that, by a simple renormalization procedure, these developments can be summed so as to obtain the exact energies in closed forms. In addition to revealing the existence of a theoretical singularity as a function of the crystal "refractivity" $\frac{4}{3}\pi N\alpha$, these closed forms are simple enough to be used in numerical computations of various crystal properties. No such calculation is attempted here.

## Raman Scattering in $KNO_3$ Phases I, II, and III

M. Balkanski, M. K. Teng, and M. Nusimovici
*Laboratoire de Physique des Solides Equipe de Recherche associée au Centre National de la Recherche Scientifique Faculté des Sciences de Paris, Paris, France*

42.3
48.2
49.8
(Received 19 March 1968; revised manuscript received 9 July 1968)
p. 1098

The Raman scattering for a complete phase-transition cycle (II → I → III → II) in $KNO_3$ is reported for the first time, with the intention to correlate the Raman-active modes in different crystalline structures. In addition to the data reported in earlier works, experimental results are obtained for the ferroelectric phase in which we noted a significant increase of intensity for all the covalent modes. A broad band with its half-width depending closely upon the temperature is also observed at 120 $cm^{-1}$ in this phase. In addition, two new lines at 65 and 133 $cm^{-1}$ are found in the room-temperature phase. Furthermore, the variation of intensity with various temperatures allows us to follow the scattering of all the observed Raman modes through the different phase transitions during a complete cycle. Using group theory, a study is made to connect various optical modes in the simple ferroelectric phase with corresponding modes in the other two phases. The Raman data presented here, together with previous infrared results, enable us to verify this deduction satisfactorily, at least for the covalent modes.

## Self-Diffusion in Solid Argon*

E. H. C. Parker, H. R. Glyde, and B. L. Smith
*School of Mathematical and Physical Sciences, University of Sussex, Falmer, Sussex, England*

43.4
48.3
(Received 19 July 1968)
p. 1107

The self-diffusion coefficient $D=D_0\exp(-Q^0/RT)$ for solid argon has been measured in thin specimens of large grain size by a tracer technique. The results, $D_0=0.2\pm_{0.1}{}^{0.3}$ $cm^2$ $sec^{-1}$ and $Q^0=3600\pm150$ cal $mole^{-1}$, are lower than those obtained in previous investigations. The value of $Q^0$ agrees reasonably well with a two-body absolute-rate calculation for vacancy migration, but not with calculations based on divacancy or interstitial mechanisms. The results suggest that vacancy diffusion takes place, and that many-body forces in solid argon are either very small, or else may satisfactorily be accounted for in an empirical two-body potential.

## Influence of Band Structure on the Nonlocal Conductivity of Metals and the Anomalous Skin Effect

M. L. Glasser
*Battelle Memorial Institute, Columbus, Ohio 43201*

42.2
44.1
45.3
(Received 5 August 1968)
p. 1110

The conductivity kernel entering into the expression for the surface impedance of a metal is calculated for a separable band structure. In the anomalous-skin-effect region, Pippard's expression is found when the Gaussian curvature on the Fermi surface is nonzero, and modifications are indicated when this is not the case.

exact energies in closed forms. In addition to revealing the existence of a theoretical singularity as a function of the crystal "refractivity" $\frac{4}{3}\pi N\alpha$, these closed forms are simple enough to be used in numerical computations of various crystal properties. No such calculation is attempted here.

The conductivity kernel entering into the expression for the surface impedance of a metal is calculated for a separable band structure. In the anomalous-skin-effect region, Pippard's expression is found when the Gaussian curvature on the Fermi surface is nonzero, and modifications are indicated when this is not the case.



## Erratum

47.2
47.5
70

**Role of Longitudinal and Transverse Phonons in Lattice Thermal Conductivity of GaAs and InSb,** C. M. BHANDARI AND G. S. VERMA [Phys. Rev. **140**, A2101 (1965)]. p. 1112

21.2
22
48.6
70

**Magnetic Interactions between Rare-Earth Ions in Insulators. I. Accurate Electron-Paramagnetic-Resonance Determination of $Gd^{3+}$ Pair-Interaction Constants in $LaCl_3$,** M. T. HUTCHINGS, R. J. BIRGENEAU, AND W. P. WOLF [Phys. Rev. **168**, 1026 (1968)]. p. 1112

SECOND SERIES, VOL. 176, NO. 4 DECEMBER 1968

## Observation of the Lowest $p$-Shell $T=\frac{1}{2}$ States of $^{11}B$ and $^{11}C$†

S. W. COSPER,* ROBERT L. MCGRATH,‡ JOSEPH CERNY, CREVE C. MAPLES, GEORGE W. GOTH, AND DONALD G. FLEMING§

*Lawrence Radiation Laboratory and Department of Chemistry, University of California, Berkeley, California 94720*

53.2
53.5
(Received 8 August 1968) p. 1113

The $^{11}B$ and $^{11}C$ $T=\frac{1}{2}$ analogs of the $^{11}Be$(0.32-MeV) state have been located utilizing the $^{12}C(p,^3He)^{11}B$ and $^{12}C(p,t)^{11}C$ reactions. The new states lie at 12.94±0.05 MeV in $^{11}B$ and at 12.47±0.06 MeV in $^{11}C$, and have total widths of 350±50 and 550±50 keV, respectively; their spins and parities are found to be $\frac{1}{2}^-$. A check on their isospin purity is achieved by examination of their charged-particle decay properties; it is found that the major decay mode is via $L=1$ isospin-allowed proton emission.

## Gamma Decays from the First $T=\frac{1}{2}$ Levels in $^{13}N$ and $^{13}C$

C. L. COCKE,* J. C. ADLOFF, AND P. CHEVALLIER

*Institut de Recherches Nucléaires, Strasbourg, France*

53.2
53.8
(Received 20 August 1968) p. 1120

The reactions $^{11}B(^3He,n)^{13}N^*$ $(T=\frac{1}{2})$ $(\gamma)$ and $^{11}B(^3He,p)^{13}C^*$ $(T=\frac{1}{2})$ $(\gamma)$ have been used to study the $\gamma$-decay modes of the lowest $T=\frac{1}{2}$ states in $^{13}N$ and $^{13}C$. Coincidences between neutrons and associated $\gamma$ rays in the case of $^{13}N$ and between protons and $\gamma$ rays in the case of $^{13}C$ were recorded in a two-dimensional array. For the $\gamma$ decay of $^{13}N$(15.07) and $^{13}C$(15.11), we find $\Gamma_{\gamma_0}/\Gamma_{p_0}=(12\pm2)\%$ and $\Gamma_{\gamma_0}/\Gamma=(0.53\pm0.06)\%$, respectively. When combined with previously available experimental information, these values yield $\Gamma=1.13\pm0.3$ and $4.7\pm1.6$ keV for the first $T=\frac{1}{2}$ levels in $^{13}N$ and $^{13}C$, respectively. Additional information on $\gamma$ branching ratios and particle decay for these levels is presented.

## Quantized Liquid Drop and Some Ground-State Nuclear Properties*

G. READING HENRY

*Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305*

(Received 31 July 1968)
51.2 p. 1126

The liquid drop is adopted as a simple nuclear model. The zero-point motion of the quantized drop is found to alter some of the properties of the classical drop, bringing the model into better agreement with experiment. The properties discussed are the skin thickness, the electric form factor for elastic scattering, and the rms nuclear radius as a function of atomic number.

## Lifetimes of Levels in $A=10$ Nuclei*

T. R. FISHER, S. S. HANNA, D. C. HEALEY, AND P. PAUL†

*Department of Physics, Stanford University, Stanford, California 94305*

(Received 6 June 1968)
53.2 p. 1130

The Doppler-shift attenuation method was used to obtain the following mean lifetimes (in psec) for the indicated nuclear levels: $^{10}C$(3.36), $\tau=0.155\pm0.025$; $^{10}B$(3.59), $\tau=0.150\pm0.015$; $^{10}Be$(3.37), $\tau=0.189\pm0.020$; $^{10}B$(2.15), $\tau=2.7_{-0.4}^{+0.8}$. A limit of $\tau<30$ fsec is obtained for $^{10}B$(1.74), which is a factor of 8 greater than, and therefore consistent with, the lifetime computed from the analog $\beta$ decay of $^{10}C$. Transition strengths obtained from the $^{10}B$(2.15) and $^{10}B$(3.59) lifetimes are in good agreement with the effective-interaction calculations of Cohen and Kurath, as modified by Warburton *et al.* The $^{10}C$(3.36) and $^{10}Be$(3.37) states decay by analog $E2$ transitions: $2^+$, $T=1\rightarrow0^+$, $T=1$, with $T_z=\pm1$, whose strengths are well described by calculations of Kurath's for an effective charge $\epsilon_n=\epsilon_p=0.5$. An upper limit was obtained for the corresponding transition $5.17\rightarrow1.74$ in $^{10}B$ ($T_z=0$) which is consistent (factor of 4 greater) with the analog strengths observed in the $T_z=\pm1$ nuclei.

## Lifetimes of Levels in $^{12}C$, $^{13}C$, and $^{13}N$†

F. RIESS, P. PAUL,* J. B. THOMAS,‡ AND S. S. HANNA

*Department of Physics, Stanford University, Stanford, California 94305*

(Received 6 June 1968)
53.2 p. 1140

The Doppler-shift method is used to obtain lifetime limits of $\tau<10$ fsec and $\tau<26$ fsec for the 3.09- and 3.68-MeV levels of $^{12}C$, respectively. The radiative width $\Gamma_\gamma$ is remeasured for the 2.37-MeV state of $^{13}N$ in the reaction $^{12}C(p,\gamma)^{13}N$ and found to be 0.45±0.05 eV, corresponding to $\tau=1.47\pm0.15$ fsec. Thus, the disagreement previously reported between the first excited analog levels is not confirmed. A total width $\Gamma=34\pm1$ keV is found for the level in $^{13}N$. The Doppler-shift limits are substantiated by observing a lifetime of 55±7 fsec for the 4.43-MeV level of $^{13}C$. For the 3.86-MeV level of $^{12}C$, a lifetime of $9.0_{-1.5}^{+2.5}$ psec is obtained.

## Reaction T($^3$He,$\gamma$)$^6$Li in the Energy Range 0.5–11 MeV*

S. L. Blatt, A. M. Young, S. C. Ling, K. J. Moon, and C. D. Porterfield
*Department of Physics, The Ohio State University, Columbus, Ohio 43210*
(Received 29 July 1968)

52.8 p. 1147

$\gamma$-ray spectra from the radiative capture of $^3$He particles by tritons have been obtained over the energy range $0.5 \leq E(^3\text{He}) \leq 11.0$ MeV. Strong transitions were seen to the ground and first two excited states of $^6$Li; excitation curves and angular distributions are presented. The integrated cross section for the inverse reaction $^6\text{Li}(\gamma_0,t)^3\text{He}$ up to $E_\gamma = 25$ MeV is found to be $9.3 \pm 1.4$ MeV mb. Evidence is also found for a transition to the second $T=1$ state of $^6$Li. The results are discussed in the framework of the direct-capture model. Substantial T+$^3$He clustering is evident in the four observed $^6$Li final states.

## Effective Interaction for Light and Intermediate Nuclei

K. P. Joshi, G. K. Mehta, and Y. R. Waghmare
*Physics Department, Indian Institute of Technology, Kanpur, India*
(Received 29 May 1968)

51.2 p. 1154

A phenomenological effective interaction is derived from the matrix elements of the Yale potential tabulated by Shakin *et al.* The form of the central interaction is assumed to be $H_{12} = (A_W W + A_B B + A_M M - A_H H) V_e e^{-(r/r_0)^2}$, where $W$, $B$, $M$, and $H$ are the usual Wigner, Bartlett, Majorana, and Heisenberg mixtures. The values of the constants $A_W$, $A_B$, $A_M$, $A_H$, $V_e$, and $r_e$ are evaluated from comparison with the Yale-potential matrix elements. The parameters of the off-diagonal tensor force are also calculated in the same fashion. Calculations with the effective interaction derived in this manner are made for light and intermediate nuclei. Remarks are made about the nature of the two interactions.

## Proton-Proton Bremsstrahlung at 47 MeV*

D. L. Mason† and M. L. Halbert
*Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

and

L. C. Northcliffe‡
*Texas A and M University, College Station, Texas 77843*
(Received 29 July 1968)

52.6
63.4
63.6 p. 1159

The cross section for proton-proton bremsstrahlung at 47 MeV was measured by detecting the two protons at 30° on either side of the beam. Strongly noncoplanar events were not accepted. The integrated cross section and differential cross section as a function of $\gamma$-ray polar angle are in reasonable agreement with recent theoretical predictions. A survey of all presently available (30°, 30°) measurements and predictions is given.

## Search for States in the Three-Neutron and Triton Systems*

Gerald G. Ohlsen, Richard H. Stokes, and P. G. Young
*Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544*
52.2
52.7 (Received 24 July 1968) p. 1163

$^3$He spectra from the bombardment of tritium and of $^3$He targets with 22.25-MeV tritons are presented. No clear evidence for new states in either residual nucleus is obtained; however, the $^3\text{H}(t,^3\text{He})3n$ spectra provide weak evidence for the existence of a "trineutron" unbound by 1 to 1.5 MeV.

## Differential Range Study of ($\alpha$,$xn$) Reactions of Copper*

N. T. Porile and I. Fujiwara†
*Department of Chemistry, Purdue University, Lafayette, Indiana*
27
46.6
54.8 (Received 8 August 1968) p. 1166

The differential ranges of the $Cu^{63}(\alpha,n)$, $Cu^{63}(\alpha,2n)$, and $Cu^{63}(\alpha,3n)$ reaction products have been measured in the energy range of 14–40 MeV by means of the electrostatic collection technique. The results have been used to derive a range-energy relation for gallium recoils in $H_2$. Comparison with the Lindhard-Scharff-Schiott calculation indicates that the latter overestimates the importance of electronic stopping. The results have been compared with a Monte Carlo evaporation calculation and have been used to obtain the average values of the neutron and photon energies. The information obtainable from transformation of the recoil velocity distribution between the c.m. and laboratory systems has been explored. These various analyses all indicate that the differential ranges and angular distributions of the recoils yield mutually consistent results.

## $C^{12}(\gamma,\dot{p})B^{11}$ Angular Distributions In and Just Above the Giant Resonance*

David E. Frederick and A. Daniel Sherick
*Institute for Atomic Research and Department of Physics, Iowa State University, Ames, Iowa 50010*
(Received 12 April 1968)

53.3 p. 1177

The energy and angular distributions of photoprotons have been observed with 30.5- and 32.1-MeV electron bremsstrahlung using the $\Delta E \times E$ coincidence technique. The angular-distribution anisotropy parameter $A_2$ has the average value $-0.56$ in the giant resonance peak from 21.8 to 23.7 MeV and varies less than $\pm 0.05$ from that value. From 24.4 to 28 MeV, variations in $A_2$ of about $\pm 0.2$ were detected and correlate somewhat with bumps seen in the total cross section. Above 28 MeV, $A_2$ decreases toward $-0.9$. No model yet exists which predicts correctly the anisotropy observed above the giant resonance. The probable nature of the particle-hole states at and above 25 MeV is deduced. The asymmetry parameters $A_1$ and $A_3$ are everywhere nonzero, have opposite signs, and exceed 0.3 in magnitude above 29 MeV, indicating moderate electric-dipole–quadrupole interference. This is interpreted as being consistent with one-particle-one-hole quadrupole excitation of $\lesssim 1\%$ relative to the dipole photoproton emission strength.

## Search for Unbound States in He$^3$ through $Li^6(\dot{p},\alpha)$†

David K. Olsen and Ronald E. Brown
*John H. Williams Laboratory of Nuclear Physics, University of Minnesota, Minneapolis, Minnesota 55455*
52.2
53.5 (Received 20 August 1968) p. 1192

The shape of the $\alpha$-particle continuum from the $Li^6(\dot{p},\alpha)$ reaction at a proton energy of 20.0 MeV (lab) has been investigated for structure due to excited states of He$^3$. $\alpha$-particle spectra were measured with thin surface-barrier detectors from 15° to 85° (lab) in steps of 5°. The maximum He$^3$ excitation energy which could have been observed with this experimental technique depended upon the lab angle and varied from 14.3 to 10.1 MeV. In order to continuously monitor the target composition, protons elastically scattered at 90° (lab) were observed simultaneously with the $\alpha$-particle spectra. No clear structure attributable to the formation of excited states of He$^3$ was observed. In particular, an upper limit of 300 $\mu$b/sr (lab) can be placed on the differential cross section at 20° (lab) for the excitation of a 12-MeV state in He$^3$ having a natural width of 0.9 MeV (c.m.).

*The spectra from the bombardment of tritium and of $^3$He targets with 22.25-MeV tritons are presented. No clear evidence for new states in either residual nucleus is obtained; however, the $^4$H$(t,^3$He$)3n$ spectra provide weak evidence for the existence of a "trineutron" unbound by 1 to 1.5 MeV.

the formation of excited states of $He^5$ was observed. In particular, an upper limit of 300 $\mu$b/sr (lab) can be placed on the differential cross section at 20° (lab) for the excitation of a 12-MeV state in $He^5$ having a natural width of 0.9 MeV (c.m.).



## Low-Energy Properties of Realistic *N-N* One-Boson-Exchange Potentials

ALEXANDER GERSTEN AND A. E. S. GREEN
*University of Florida, Gainesville, Florida 32601*

51.6
64.9
(Received 29 July 1968)
p. 1199

We examine the low-energy features of the *N-N* interaction, as described by three realistic one-boson-exchange potential models. These models are the Green-Sawada two-parameter model, the Bryan-Scott III model, and the Ueda-Green I model. We calculate the deuteron binding energy, wave functions, magnetic and quadrupole moments, effective range, and electromagnetic form factors. Where possible, these quantities are compared with the experimental data.

## Alpha-Particle Yields and Angular Distributions in the $O^{16}(Li^6,\alpha_0)F^{18}$ Reaction from 4.8 to 13.8 MeV*

M. WAYNE GREENE†
*Department of Physics and Astronomy, Iowa City, Iowa 52240*

(Received 31 January 1968; revised manuscript received 21 June 1968)
53.9
p. 1204

The yield and angular distributions of $\alpha$ particles from the $O^{16}(Li^6,\alpha_0)F^{18}$ reaction were measured for the bombarding range 4.8 to 13.8 MeV. Nine distinct peaks were observed in the yield curve measured at 0° and had peak-to-valley ratios varying from 1.3 to 6.0. A fluctuation analysis of the yield curve gives a corrected coherence width $\Gamma=0.49\pm0.40$ MeV (c.m. system) in the excitation energy range of $Na^{23}$ of 18.0 to 24.6 MeV for the sample size $n=5.3$. This analysis predicts a direct reaction contribution to the differential cross section of 0 to 60%. Angular distributions were measured at seven energies: 5.50, 5.70, 6.22, 11.60, 12.20, 12.80, and 13.30 MeV, which correspond to peak and valley energies observed in the yield curve. At the three lowest bombarding energies, the angular distributions have little structure, while at the four higher energies they oscillate rapidly.

## Effects of Using a Velocity-Dependent Potential in a Monte Carlo Simulation of Intranuclear Cascades*

K. CHEN, G. FRIEDLANDER, AND J. M. MILLER
*Chemistry Departments, Brookhaven National Laboratory, Upton, New York 11973*
*and*
*Columbia University, New York, New York 10027*

(Received 21 August 1968)
51.6
p. 1208

A velocity-dependent potential, of the form $V=V_0(1-\epsilon/\epsilon_{max})$ for $\epsilon<\epsilon_{max}$ and $V=0$ for $\epsilon\geq\epsilon_{max}$, was used in a Monte Carlo simulation of intranuclear cascades. By using a reasonable $\epsilon_{max}$ (150 MeV), only slightly better agreement is obtained between the calculated and experimental results than was found previously with a velocity-independent potential.

## Nonexistence of the 14.6-MeV State in $Be^7$†

P. D. PARKER, D. W. MINGAY,* AND J. C. OVERLEY‡
*Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut*

53.2
53.5
(Received 1 July 1968)
p. 1211

A level has been previously reported at an excitation energy of 14.6 MeV in $Be^7$ from a study of the $B^{10}(p,\alpha)Be^7$ reaction using range techniques. This reaction has been reexamined using energy-sensitive detectors, and the $\alpha$ particles previously attributed to this level have been identified, instead, as recoiling $Be^7$ ions and as $\alpha$ particles from the breakup of recoiling $Be^8$ nuclei.

## Coupled-Channel Calculation of $C^{13}$-Neutron Scattering

J. T. REYNOLDS, C. J. SLAVIK, C. R. LUBITZ, AND N. C. FRANCIS
*Knolls Atomic Power Laboratory, Schenectady, New York* 12301*

51.6
53.6
(Received 2 August 1968)
p. 1213

Coupled-channel calculations are described for the interaction between a neutron and $C^{13}$. Emphasis is placed on the incident-energy region between 0 and 5 MeV, although the bound states are also calculated. Precise fits to total, elastic differential, and polarization cross sections are obtained. Comparisons with other treatments of the $A=13$ system are made, and the differences are discussed, in particular the meaning of the weak-coupling approximation. Deficiencies in the present method of calculation are also discussed.

## $^6$Li$(p,p')^6$Li(3.56 MeV) Reaction from $E_p=24.3$ to 46.4 MeV and the Effective Interaction*

S. M. AUSTIN, P. J. LOCARD,† W. BENENSON, AND G. M. CRAWLEY
*Department of Physics, Michigan State University, East Lansing, Michigan*

(Received 15 July 1968)
53.5
p. 1227

The total cross section for the $^6$Li$(p,p')^6$Li(3.56 MeV) reaction was measured by observing the isotropic 3.56-MeV de-excitation $\gamma$ rays in a 20-cm$^3$ Ge(Li) detector and was found to decrease slowly with energy. In a microscopic model of the reaction, this cross section depends only on the spin-isospin–dependent part $V_{11}$ of the effective interaction. At energies above 34 MeV, the data are well described by a potential, $V_{11}=Ve^{-\alpha r}/\alpha r$, where the range $1/\alpha$ is taken to be 1.0 F, and $V=12.1$ MeV. At 25 MeV, $V=11.1$ MeV fits the data. The impulse approximation predicts a cross section larger than the data for the energy range of this experiment, the ratio decreasing from 2.9 at 25 MeV to 1.4 at 45 MeV. Available evidence on the spin-isospin–dependent interaction is summarized. For proton energies between 23 and 52 MeV, the strength of $V_{11}$ lies in the range $12.5\pm2.5$ MeV and does not appear to vary with energy.

## Comparison of Variational Results and Solutions of Faddeev Equation for a Local Potential*

I. R. Afnan† and Y. C. Tang
*School of Physics, University of Minnesota, Minneapolis, Minnesota 55455*
(Received 29 July 1968)

51.2 p. 1232

A comparison is made between the results obtained for a three-body system with a local Yukawa potential, using the Faddeev method and a variational technique. The result of this comparison shows that with the type of trial function used, the variational method yields upper and lower bounds which are very close to each other and consistent with the results obtained by Ball and Wong. On the other hand, our variational study rules out definitely the possibility of a ground-state collapse phenomenon claimed by Osborn, since Osborn's ground-state energy is even lower than the lower bound of our calculation when the potential depth is large.

## Study of $He^3+He^4$ and $H^3+He^4$ Systems with the Resonating-Group Method†

Ronald E. Brown and Y. C. Tang
*School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455*
51.6
52.2
52.8
(Received 22 July 1968)

p. 1235

The resonating-group method, which employs a completely antisymmetric wave function, has been used to consider the problem of elastic scattering of $He^3$ and $H^3$ by $He^4$. The nucleon-nucleon potential used in the calculation is purely central, but fits the low-energy scattering data satisfactorily. The calculated phase shifts are compared with those which have been obtained from an analysis of experimental data, and rather good agreement is found. In particular, the calculated $l=3$ phase shift for both systems exhibits a resonance behavior which indicates the presence of a $^2F$ level lying between the $^2F_{7/2}$ and $^2F_{5/2}$ levels found experimentally. Effective, local, $l$-dependent potentials between the $He^4$ cluster and the $He^3$ or $H^3$ cluster have also been derived. They are approximately energy-independent and contain features which have been found in phenomenological analyses of elastic scattering in light systems. Effects due to specific distortion of the $He^3$ or $H^3$ cluster have also been examined in an approximate fashion. Here it is found that the effects on the $^2F$ excitation energy and on the nonresonant phase shifts are only of minor importance.

## $Be^9(p,p\alpha)He^5$ Reaction at 57 MeV*

P. G. Roos,† H. G. Pugh, Mahavir Jain, H. D. Holmgren, and Martin Epstein‡
*University of Maryland, College Park, Maryland 20742*
and
C. A. Ludemann
*Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*
(Received 12 August 1968)

53.5 p. 1246

The $Be^9(p,p\alpha)He^5$ reaction was studied using 57-MeV protons from the Oak Ridge isochronous cyclotron. The correlated energies of both the emitted protons and $\alpha$ particles were measured at detection angles $(\theta_p,\theta_\alpha)$ of (94°, −35.3°), (105°, −30°), and (116°, −25.1°), where the detectors were coplanar with the beam. In addition, an angular correlation was measured by fixing $\theta_p$ at 105° and varying $\theta_\alpha$ from −21° to −39° in 3° steps. The data for the reaction leading to the ground state of $He^5$ were found to be consistent with quasifree scattering of the incident protons by $S$-state $\alpha$-particle clusters in $Be^9$. Analysis in terms of a plane-wave impulse approximation yields a momentum density distribution for the struck $\alpha$ particles which has a half-width of 0.27 $F^{-1}$, and a probability of finding an $\alpha$-particle cluster in $Be^9$ of $0.25_{-0.15}{}^{+0.35}$.

## Analysis of Nuclear Scattering by Regge Poles

R. Shanta and C. S. Shastry*
*Saha Institute of Nuclear Physics, Calcutta, India*
51.6
53.8
(Received 23 July 1968)

p. 1254

The validity and usefulness of the complex angular-momentum formulation in nuclear scattering are investigated by studying the elastic scattering of $\alpha$ particles by $He^4$, $C^{12}$, and $O^{16}$ in terms of the Regge trajectories through suitable Regge-type representations for the $S$ matrix. The trajectories are obtained from the resonant levels of the compound nuclei, and residues are calculated by imposing unitarity on the Regge-type representations for the $S$ matrix. The differential cross sections obtained by this method are compared with those obtained by experiment and by the Ackhiezer-Pomeranchuk-Blair-McIntyre model with resonant phase shifts. In order to establish the merit of the Regge-pole approach, cross sections are calculated in terms of the poles of the $S$ matrix in the momentum plane and compared with the results obtained by using the complex angular-momentum formulation. These studies provide an interesting method for the analysis of nuclear scattering.

## Scattering of 24.5-MeV Protons from $^{89}Y$

W. Benenson, S. M. Austin, and R. A. Paddock
*Michigan State University, East Lansing, Michigan**
and
W. G. Love†
*Oak Ridge National Laboratory, Oak Ridge, Tennessee‡*
(Received 12 July 1968)

54.5 p. 1268

Scattering of 24.5-MeV protons from $^{89}Y$ has been measured. Angular distributions were obtained for the ground state and the first four excited states as well as for several unresolved multiplets. The inelastic scattering data have been analyzed, using the collective model and a microscopic model with and without core-polarization effects.

## Hindrance Factors for Beta Decays of Heavy Nuclei*

Hiroyasu Ejiri†
*Department of Physics, University of Washington, Seattle, Washington 98105*
and
Kiyomi Ikeda
*Department of Physics, University of Tokyo, Tokyo, Japan*
and
Jun-Ichi Fujita†
*Department of Physics, Indiana University, Bloomington, Indiana*
54.2
55.2
(Received 26 March 1968)

p. 1277

The schematic model proposed by Brown and Bolsterli, and applied to the giant dipole resonance, is extended to the $\beta$ and $\gamma$ transitions of heavy nuclei. Special emphasis is placed on the extent to which forbidden $\beta$ decays of heavy nuclei are hindered because of possible giant resonances corresponding to those found in the electromagnetic transitions. A new method of calculating hindered forbidden nuclear matrix elements is proposed on the basis of the schematic model. It is shown that the hindrance factor due to the giant resonance effect is roughly 4 for the first-forbidden $\beta$ transitions. Systematics of unique first-forbidden transitions are examined from this viewpoint.

with quasifree scattering of the incident protons by 3-state $\alpha$-particle clusters in $Be^9$. Analysis in terms of a plane-wave impulse approximation yields a momentum density distribution for the struck $\alpha$ particles which has a half-width of 0.27 $F^{-1}$, and a probability of finding an $\alpha$-particle cluster in $Be^9$ of $0.25_{-0.12}^{+0.38}$.

elements is proposed on the basis of the schematic model. It is shown that the hindrance factor due to the giant resonance effect is roughly 4 for the first-forbidden $\beta$ transitions. Systematics of unique first-forbidden transitions are examined from this viewpoint.



## $2^-$ Isobaric Analog Resonance in the $^{89}Y(p,n_2)^{89}Zr$ Reaction and the Excited States of $^{89}Zr$†

G. C. Dutt, F. Gabbard, J. J. Egan, and J. E. Wiest
*Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506*

54.2 (Received 10 July 1968)
54.5 p. 1289

The $(p,n)$ reaction on $^{89}Y$ has been studied around the $2^-$ isobaric analog resonance at the proton energy of 4.807 MeV. Differential cross sections have been measured for the neturon groups which leave $^{89}Zr$ in the ground state and the excited states at 0.592 and 1.096 MeV. Angular distributions of the neutron groups which leave $^{89}Zr$ in the excited states at 1.096, 1.465, and 1.645 MeV have been measured. The results are compared with the predictions of Robson's theory and statistical model.

## $^{31}P(d,\alpha)^{29}Si$ Reaction from 7.3 to 12.0 MeV*

G. A. Lock, J. R. Curry, P. J. Riley, and C. G. Shugart
*The University of Texas at Austin, Austin, Texas 78712*

(Received 1 April 1968)
54.7 p. 1293

Cross sections for the reaction $^{31}P(d,\alpha)^{29}Si$ have been measured for laboratory deuteron energies from 7.300 to 12.020 MeV. The data have been analyzed in terms of Ericson fluctuation theory, from which the coherence width in $^{32}S$ has been obtained for the whole range of data and for the data divided into halves. The fraction of the reaction proceeding via a direct mechanism has also been determined by Ericson-type analysis. To obtain this fraction, it was necessary to take into account the particle decay of the compound nucleus through 3040 channels in order to calculate realistically the fluctuation damping coefficient.

## High-Resolution Study of Isobaric Analog Resonances in $^{23}Na$

G. A. Keyworth,* P. Wilhjelm,† G. C. Kyker, Jr.,‡ H. W. Newson, and E. G. Bilpuch
*Duke University, Durham, North Carolina*§

(Received 16 July 1968)
54.5 p. 1302

Excitation functions for the elastic scattering of protons by $^{23}Ne$ have been measured at 90°, 105°, 120°, 135°, 150°, and 160° from 0.8 to 3.13 MeV, and for the reaction $^{23}Ne(p,p')^{23}Ne^*$ (first excited state), at 90°, 120°, and 150° from 2.0 to 3.13 MeV, with an average energy resolution of about 250 eV. Spins, parities, and partial and total widths have been extracted for the large majority of the 76 resonances observed. Two isobaric analog states, those of the sixth and seventh excited states of $^{23}Ne$, have been identified. Both analogs are evidenced as fragmentations of the broad $T_>$ states into enhancement of the background $T_<$ states. A sum rule applied to the individual fine-structure widths implies spectroscopic factors in agreement with those extracted from $(d,p)$ stripping measurements on $^{23}Ne$.

## $Ne^{22}(t,p\gamma)Ne^{24}$ Angular Correlation Study*

J. A. Becker, L. F. Chase, Jr., R. E. McDonald, and E. K. Warburton†
*Lockheed Palo Alto Research Laboratories, Palo Alto, California 94304*

(Received 21 August 1968)
54.2 p. 1310

The 1.99-, 3.87-, and 4.76-MeV levels of $Ne^{24}$ have been studied employing particle-$\gamma$ coincidence techniques. The $Ne^{22}(t,p)Ne^{24}$ reaction was used to populate the levels in $Ne^{24}$, employing incident triton bombarding energies near 2.5 MeV. Coincident $p$-$\gamma$ pulse-height distributions were measured employing two-parameter analysis. Reaction protons were detected near 180° with respect to the incident beam direction in an annular solid-state detector, while $\gamma$-ray yields were measured at 0, 30, 45, 60, and 90° to the incident beam direction with a 10.2×10.2-cm NaI(Tl) crystal. The 3.87-MeV level was found to decay (90±2)% via cascade through the 1.99-MeV level (3.87 → 1.99 → 0), and (10±2)% via direct ground-state transitions. The 4.76-MeV level decays 100% via cascade through the 1.99-MeV level (4.76 → 1.99 → 0); an upper limit of 3% was placed on the 4.76 → 0 mode. Assuming spin 0 for the $Ne^{24}$ ground state, analysis of measured $\gamma$-ray angular distributions demands $J=2$ for both the 1.99- and 3.87-MeV levels and restricts the spin of the 4.76-MeV level to $J=0$, 1, or 2. The 3.87 → 1.99 transition has an $(L+1)/L$ multipole admixture of $x=-(0.15\pm0.15)$. An upper limit, $\tau_m \lesssim 3\times10^{-9}$ sec, was set for the mean lifetimes of the 1.99-, 3.87-, and 4.76-MeV levels.

## Direct Neutron Capture in $Co^{59}(n,\gamma)Co^{60}$†

O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone,* and M. Beer
*Brookhaven National Laboratory, Upton, New York 11973*

(Received 12 August 1968)
54.6 p. 1314

The variation in intensity of 40 individual $\gamma$ rays produced by neutron capture in cobalt was observed for neutron energies less than 1500 eV. The observed variations were consistent with the existence of a direct component in the radiative capture reaction mechanism. A direct-capture cross section of 9.2±2.4 mb at 1-eV neutron energy was deduced for the 7.492-MeV ground-state transition.

## Symmetric-Core Collective Model for Odd-Odd Nuclei with Applications in the 2*s*-1*d* Shell

R. J. Ascuitto,* D. A. Bell, and J. P. Davidson
*Department of Physics, University of Kansas, Lawrence, Kansas† 66044*

51.2 (Received 6 June 1968)
54.1 p. 1323

A model for odd-odd nuclei is described in which the odd neutron and proton are coupled to a symmetric, rotating core. The Hamiltonian consists of four parts: $H_R$, the Hamiltonian for a rotating core of fixed shape; $H_p$ and $H_n$, the Hamiltonians for a proton and a neutron moving in a symmetric oscillator potential with $\mathbf{l}\cdot\mathbf{s}$ and $\mathbf{l}^2$ terms; and $V_{pn}$, the residual neutron-proton interaction. This latter was taken to have a Gaussian radial dependence with a Serber exchange mixture with parameters picked to reproduce the low-energy singlet and triplet scattering lengths. The energy eigenvalues were obtained by an exact diagonalization of the total Hamiltonian using a core-particle basis to which a truncation procedure is applied to account for the filling of the shells. The model has been applied to $^{28}Al$, $^{30}P$, $^{32}P$, and $^{36}Cl$, determining the core-strength parameter $P$, the deformation parameter $\beta$, and the well-depth parameter $\lambda$ by fitting to the known energy-level sequence. The state functions so obtained were used to calculate static magnetic dipole and electric quadrupole moments, and for $^{30}P$ the mixing ratio $\delta^2$ for two $2^+$ to ground transitions. The fit to the measured energy levels is quite successful; however, only in $^{28}Al$ and $^{30}P$ is the residual neutron-proton interaction needed. The values obtained for the static moments are rather poor. The results are compared, where possible, to a shell-model calculation.

## Gamma Rays from the Decay of $^{75}$Ge and $^{77}$Ge†

ANNE NG, R. E. WOOD, AND J. M. PALMS
*Physics Department, Emory University, Atlanta, Georgia 30322*
AND
P. VENUGOPALA RAO* AND R. W. FINK
*School of Chemistry, Georgia Institute of Technology, Atlanta, Georgia 30332*
(Received 30 July 1968)
54.2 p. 1329

γ spectra from the decay of 82.2-min $^{75}$Ge and 11.3-h $^{77}$Ge have been studied with several sizes of high-resolution Ge(Li) detectors by singles and coincidence methods. Energies and relative intensities of 7 transitions in the decay of $^{75}$Ge and 67 transitions in $^{77}$Ge decay have been determined. The transitions in the decay of $^{75}$Ge are placed in a level scheme of $^{75}$As consisting of levels at 199.2, 264.7, 468.7, and 617.8 keV. All 67 transitions in the $^{77}$Ge decay are placed in a level scheme of $^{77}$As with levels at 215.6, 264.4, 475.4, 632.0, 634, 795.6, 1077.4, 1094.0, 1190.3, 1214.9, 1319.7, 1339.0, 1378.2, 1384, 1399.5, 1458.3, 1494.7, 1528.4, 1539.2, 1560.8, 1573.3, 1863.9, 2000.3, 2104.9, 2110.9, 2202.2, 2244.8, 2301.7, 2342.0, 2353.4, 2436.6, and 2513.6 keV.

## ($^3$He,α) Reaction on $^{89}$Y and $^{86}$Kr at 18 MeV*

C. M. FOU† AND R. W. ZURMÜHLE
*Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104*
(Received 19 April 1968)
54.8 p. 1339

Neutron hole states in $N=49$ nuclei were studied with the ($^3$He,α) reaction on $^{89}$Y and $^{86}$Kr. Spectroscopic information was obtained from a distorted-wave Born-approximation analysis. Various optical potential wells were used. The results were compared and found to be in good agreement with each other. In $^{88}$Y, the ground state and the first excited state (0.40 MeV) are excited by $1g_{9/2}$ neutron pickup. The coupling of the unpaired $2p_{1/2}$ proton to the $1g_{9/2}$ neutron hole yields $4^-$ and $5^-$ states. Assuming that these two states represent the total $T<g_{9/2}$ neutron pickup strength in $^{88}$Y, the sum of their spectroscopic factors is normalized to 10. Using the same normalization factor for $^{87}$Kr states, the spectroscopic factor for the ground state excited by $1g_{9/2}$ neutron pickup represents only 60% of the total $T<g_{9/2}$ neutron pickup strength. Two other possible $\frac{9}{2}^+$ neutron hole states were observed at 1.89- and 2.03-MeV excitation. Spectroscopic information about other neutron hole states observed is also presented.

## Dipole States in $Sr^{88}$

B. GOULARD*
*Université Laval, Quebec, Canada*
AND
T. A. HUGHES†‡ AND S. FALLIEROS§
*Bartol Research Foundation of the Franklin Institute, Swarthmore, Pennsylvania 19081*
51.2
(Received 25 July 1968)
54.3 p. 1345

A calculation of the dipole states in $Sr^{88}$ is presented. In addition to the conventional one-particle–one-hole configurations, the calculation includes a set of two-particle–two-hole excitations, with the additional particle-hole pair coupled to angular momentum zero and isospin zero or one. This not only increases the number of degrees of freedom but also allows for the appearance of states with definite isospin in the final results. The dipole spectrum separates now into two groups of states with definite isospin. One group corresponds to isospin $T$ equal to that of the ground state. It contains the giant dipole resonance of the nucleus and most of the ground-state dipole strength. The states in the second group are analog states with isospin $T+1$. They are fewer in number and lie systematically at higher energies relative to the members of the first group. They are also found to exhibit typical dipole features such as the presence of a coherent state at the high-energy side of the spectrum. The positions and the radiative strengths of the calculated levels are discussed.

## Level Spectra of Odd Isotopes of Ga, As, Br, and Rb in the Coriolis Coupling Model with a Residual Interaction of the Pairing Type*

W. SCHOLZ
*Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19104*
AND
F. B. MALIK†
*Physics Department, Yale University, New Haven, Connecticut 06520*
(Received 29 July 1968)
51.2
54.2 p. 1355

Low-lying positive- and negative-parity states of odd isotopes of Ga, As, Br, and Rb in the mass region bounded by $30<Z<38$ and $40\leq N\leq 48$ have been calculated in the Coriolis coupling model with the incorporation of a residual interaction of the pairing type in calculating the intrinsic states. The single-particle energy levels and wave functions are first computed in a deformed well with a spin-orbit strength of $-0.26\hbar\omega_0$ and for a well-flattening parameter $D$ between $-0.035\hbar\omega_0$ and $-0.06\hbar\omega_0$. These values are consistent with the observed location of the $1f_{5/2}$, $2p_{3/2}$, and $2p_{1/2}$ states in $Sc^{41}$ and $Sc^{49}$. The deformation $\beta$ has been restricted to a range around $\beta=\pm 0.2$ which is consistent with the observed $B(E2)$ value to the first excited $2^+$ state of neighboring even-even nuclei, assuming a rotational character for this state. Using the orbitals in the deformed well as vacuum states, new particle states are calculated for a residual interaction of the pairing type, using a pairing-force strength consistent with the observed odd-even mass difference and the Bardeen-Cooper-Schrieffer (BCS) variational formalism. The complete variational calculation has been carried out for the ground, the particle, and the core excited states with due consideration of the blocking effect. This procedure, which differs from the usual quasiparticle treatment, ensures that the particle and core excited states are orthonormal to each other and to the ground state and that the average particle number is conserved in each configuration. Band-head energies and the unperturbed bands built on them are calculated, using these new renormalized single-particle states and the moment of inertia obtained from the excitation energy of the first excited $2^+$ state of neighboring even-even nuclei, assuming a rotational character for this state. Using the same moment of inertia and the computed wave functions of the deformed well, the Coriolis coupling matrix elements between these bands are calculated. The inclusion of the residual interaction introduces multiplicative "overlap factors" into the Coriolis coupling strength which results in a reduction of its magnitude for off-diagonal terms. These overlap factors have been calculated from the BCS wave functions. Thus we have used no arbitrary free parameters in the computation. The final spectra of the negative- and positive-parity states are obtained by a diagonalization procedure, using, respectively, the bands built on the 10 Nilsson states in the $1f$-$2p$ shell and on the 15 Nilsson states in the $1g$-$2d$-$3s$ shell. The model can correctly account for (i) the observed ground-state spins for all nuclei in this region, (ii) the large number of negative-parity states with spins $\leq\frac{5}{2}^-$ below 1-MeV excitation energy, and (iii) the occurrence of several low-lying positive-parity states, in particular a low-lying $\frac{3}{2}^+$, $\frac{1}{2}^+$ doublet.

configurations, the calculation includes a set of two-particle–two-hole excitations, with the additional particle-hole pair coupled to angular momentum zero and isospin zero or one. This not only increases the

number of negative-parity states with spins $\leq \frac{5}{2}^-$ below 1-MeV excitation energy, and (iii) the occurrence of several low-lying positive-parity states, in particular a low-lying $\frac{3}{2}^+$, $\frac{5}{2}^+$ doublet.



## Measurements of the $^{63}Cu(\gamma,n)$ and $(\gamma,2n)$ Cross Sections*

R. E. Sund, M. P. Baker,† L. A. Kull, and R. B. Walton‡
*Gulf General Atomic Incorporated, San Diego, California 92112*
(Received 12 August 1968)
54.3 p. 1366

The $^{63}Cu(\gamma,n)$ cross section was measured over the energy range from threshold to 25 MeV with a photon beam of 2.0% resolution which was produced by the inflight annihilation of positrons. The $(\gamma,n)$ cross section was found to have a maximum value of 75±6 mb at about 17.1 MeV and an integrated value up to 25 MeV of 490±40 MeV mb. No structure was observed in these measurements or in additional $(\gamma,n)$ measurements which were made in the region of the peak of the giant resonance with 1.5% $\gamma$-ray resolution. The $(\gamma,n)$ data from the present experiment were combined with the $(\gamma,n)+(\gamma,pn)$ data from Livermore to obtain the $^{63}Cu(\gamma,pn)$ cross section, which was found to have a maximum value of 15±4 mb at about 23 MeV and an integrated value up to 25 MeV of 60±15 MeV mb. In addition, the $^{63}Cu(\gamma,2n)$ cross section was measured at three representative energies between threshold and 26 MeV. The maximum $(\gamma,2n)$ cross section obtained was 10.0±1.6 mb at 23.7 MeV. The results of the experiments are compared with previous measurements and with theory. A small bump in the $(\gamma,n)+(\gamma,pn)+(\gamma,2n)$ cross section at about 23 MeV may possibly be attributed to an analog giant resonance.

## New Isotopes of Thorium Studied with an Improved Helium-Jet Recoil Transport Apparatus*

Kalevi Valli and Earl K. Hyde
*Lawrence Radiation Laboratory, University of California, Berkeley, California 94720*
55.2
(Received 14 June 1968)
55.9 p. 1377

Five neutron-deficient isotopes of thorium lighter than mass 218 were studied at the Berkeley Heavy Ion Linear Accelerator by bombardment of enriched $^{206}Pb$ with $^{16}O$. Silicon (Au) surface-barrier detectors were used in on-line measurements performed to determine $\alpha$-decay characteristics. Mass-number assignments of $^{213}Th$ through $^{217}Th$ were made on the basis of excitation functions and systematic trends in $\alpha$-decay properties. Half-lives and $\alpha$-particle energies were determined. New information was also obtained about the $\alpha$-decay characteristics of $^{216}Ac$, $^{215}Ra$, $^{214}Fr$, and $^{213}At$. Systematic occurrence of complex structure in the $\alpha$ decay of even-$Z$ 125-neutron nuclei is discussed, and spins and parities are suggested for three lowest-energy levels of $^{211}Ra$, $^{209}Rn$, and $^{207}Po$. Systematic occurrence of isomerism in odd-$Z$ 127-neutron nuclei is also discussed, and spins and parities are suggested for several levels. On the basis of the extreme regularity of the experimental $\alpha$ energies, predictions are made for the energies of several unknown neutron-deficient isotopes of thorium, protactinium, uranium, and neptunium. In the experimental work, the helium-jet transport method was used to remove the $\alpha$-emitting products from the target region. Technical details concerning the application of the method to millisecond activities are discussed.

## High-Energy Scattering at Moderately Large Angles*

L. I. Schiff
*Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305*
52.6
64.9
(Received 12 August 1968)
65 p. 1390

The applicability of the eikonal approximation to high-energy nucleon-nucleus and hadron-hadron collisions is limited to small angles of scattering. However, experimental results have in some cases been interpreted by applying this theory beyond its angular range of validity. In the present paper, an expression for the scattering amplitude is obtained that has much of the simplicity of the eikonal approximation, but a much greater angular range of application. It provides a natural explanation for the disagreement between the Brookhaven and Virginia data on high-energy proton-$He^4$ elastic scattering in the neighborhood of the first minimum.

## Nuclear-Matter Sizes in the Tin Isotopic Sequence*†

Richard N. Boyd‡ and G. W. Greenlees
*Department of Physics, University of Minnesota, Minneapolis, Minnesota 55455*
55.1
(Received 27 June 1968)
55.5 p. 1394

Differential cross sections and polarizations have been measured for 39.6-MeV protons elastically scattered from $^{116}Sn$, $^{118}Sn$, $^{120}Sn$, $^{122}Sn$, and $^{124}Sn$. These data were analyzed with the optical model of Greenlees, Pyle, and Tang to extract nuclear-matter rms radii. These radii are significantly greater than the corresponding proton radii, and indicate that the neutrons added between successive even isotopes are added to the surface of the neutron distribution, with the exception of the isotope pair $^{118}Sn$-$^{120}Sn$, in which case an anomaly occurs which suggests a structural rearrangement.

## $g_{7/2}$-$h_{11/2}$ Anomaly in Stripping Studies near $A=110$†

B. L. Cohen, R. A. Moyer, J. B. Moorhead, L. H. Goldman, and R. C. Diehl
*University of Pittsburgh, Pittsburgh, Pennsylvania 15213*
51.6
55.7
(Received 5 April 1968)
p. 1401

Judging from summed spectroscopic factors ($\Sigma S$) in $(d,p)$ reactions at 12 MeV, the $g_{7/2}$ state seems to be almost empty while the $h_{11/2}$ state seems to be almost full in the isotopes of Pd, Cd, and In. This is the reverse of the results in the isotopes of Sn, and is sharply contrary to expectations from nuclear-structure theory, since the $g_{7/2}$ state lies much lower in energy than the $h_{11/2}$. This anomaly was investigated with 17-MeV-deuteron-induced $(d,p)$ and $(d,t)$ reactions. In the former, where the behavior is much less sensitive to the vagaries of the distorted-wave Born approximation than at 12 MeV, the same general results are obtained, although the effect is not as strong. In the $(d,t)$ studies, there is very little anomaly in $\Sigma S$, but there are some suspicious aspects of this result. $S(d,p)$ for exciting various $7/2^+$ nuclear levels was found to have very different ratios at 12 and 17 MeV, and $S(d,p)/S(d,t)$ varies much more strongly than usual among these levels. It is concluded that the anomaly arises from a breakdown of the basic stripping theory.

## Small-Angle Scattering of Neutrons by Heavy Nuclei*

F. T. Kuchnir, A. J. Elwyn, J. E. Monahan, A. Langsdorf, Jr., and F. P. Mooring
*Argonne National Laboratory, Argonne, Illinois 60440*
(Received 16 August 1968)
54.6 p. 1405

The differential cross sections and polarizations of neutrons elastically scattered by U, Th, Pb, Au, W, and Cd have been measured for scattering angles between 1.75° and 15°. The range of neutron energies covered is from 0.6 to 1.6 MeV. These data show no evidence for any anomalous long-range neutron-nucleus interaction. The data are used to evaluate an upper limit for the absolute value of the real part of the forward-scattering amplitude at each energy for each of the above scattering samples. The polarization of neutrons that emerge at 51° relative to the proton-beam direction in the $^7Li(p,n)^7Be$ reaction (the neutron-source reaction) is determined by use of these small-angle results for proton energies between 2.47 and 3.55 MeV. Some of the advantages of the use of small-angle neutron scattering as a polarization analyzer are discussed.

## Experimental Study of the $(d,He^3)$ Reaction on Even-$A$ Isotopes of Mo*

H. OHNUMA AND J. L. YNTEMA
*Argonne National Laboratory, Argonne, Illinois 60439*
(Received 5 August 1968)
55.7 p. 1416

The $(d,He^3)$ reactions on $Mo^{95,94,96,98}$ and the $Mo^{92}(He^3,d)$ reaction were studied with 23-MeV deuterons and 34-MeV $He^3$ particles from the Argonne cyclotron. Experimental angular distributions were analyzed on the basis of the distorted-wave Born-approximation theory to determine the $l$ values and spectroscopic factors. Results were compared with previous data and the shell-model predictions. Experimental strengths of the $g_{9/2}$ and $p_{1/2}$ components in the ground state of $Mo^{93}$ are consistent with the calculations. Very low-lying states with large $p_{3/2}$ and $f_{5/2}$ strength were observed.

## Neutron Resonances of $Th^{230}$†

R. E. COTÉ,* H. DIAMOND, J. E. GINDLER, AND HLA SHWE‡
*Argonne National Laboratory, Argonne, Illinois 60439*
(Received 1 July 1968)
55.6 p. 1421

The total neutron cross section of $Th^{230}$ has been studied from 0.05 to about 500 eV with the Argonne fast chopper. Resonance parameters are given for many of the approximately 20 resonances observed below 300 eV. The value of the $s$-wave neutron strength function, based on these parameters, is $S_0=(1.3_{-0.5}^{+0.6})\times10^{-4}$. The radiation width is $\Gamma_\gamma=24\pm2$ meV. A calculation of the resonance-capture integral leads to the value $1020\pm30$ b. Comparing this result with a direct measurement of the resonance-capture integral supports the value of 75 200 yr for the half-life of $Th^{230}$ used in the derivation of the latter.

## Determination of Total Widths and Resonance Energies of the Single-Particle Analog Resonances in $^{209}Bi$*

W. R. WHARTON,† P. VON BRENTANO,‡ W. K. DAWSON,§ AND PATRICK RICHARD
*Department of Physics, University of Washington, Seattle, Washington 98105*
(Received 5 August 1968)
55.5 p. 1424

Excitation functions for the inelastic scattering of protons from $^{208}Pb$ have been obtained for incident proton energies from 14 to 18 MeV. Resonances corresponding to the first seven single-neutron isobaric analog states (IAR) of $^{209}Pb$ are observed. Many of the inelastic-scattering excitation functions show a resonance at only one of the IAR. These excitation functions were fitted with a five-parameter formula which consists of a resonance amplitude and an energy-independent background amplitude. For some excitation functions, additional resonance amplitudes were included. The analogs of the $g_{9/2}$ (ground-state), $i_{11/2}$(0.79-MeV), $j_{15/2}$ (1.41-MeV), $d_{5/2}$ (1.56-MeV), $s_{1/2}$ (2.03-MeV), $g_{7/2}$ (2.47-MeV), and $d_{3/2}$ (2.52-MeV) states are found to have total widths of $253\pm10$, $224\pm20$, $201\pm25$, $308\pm8$, $319\pm15$, $288\pm20$, and $279\pm20$ keV, respectively. In respective order, the resonance laboratory energies are $14.918\pm0.006$, $15.716\pm0.010$, $16.336\pm0.015$, $16.496\pm0.008$, $16.965\pm0.014$, $17.430\pm0.010$, and $17.476\pm0.010$ MeV.

SECOND SERIES, VOL. 176, NO. 5 DECEMBER 1968

## Effect of the Anomalous Magnetic Moment of the Electron on the Nonlinear Lagrangian of the Electromagnetic Field

R. F. O'CONNELL
*Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana*
(Received 28 June 1968)
62.8 p. 1433

When the anomalous magnetic moment of the electron ($g\neq2$) is considered, by adding a phenomenological Pauli term to the Dirac Hamiltonian, the exact solutions to the Dirac equation can still be found. Using these solutions, and the methods of Heisenberg and Euler and of Weisskopf, we derive, in addition to the usual nonlinear term, a new nonlinear term which is correct to relative order $\alpha^3$.

## Quantum Theory of an Electron Gas with Anomalous Magnetic Moments in Intense Magnetic Fields

HONG-YEE CHIU* AND VITTORIO CANUTO†
*Institute for Space Studies, Goddard Space Flight Center, National Aeronautics and Space Administration New York, New York*

AND

LAURA FASSIO-CANUTO
*Department of Physics Centro de Investigacion y de Estudios Avanzados del I. P. N., Ap. Post 14740 Mexico 14, D. F.*
(Received 27 June 1968)
61.4
64.4 p. 1438

In this paper we have continued our investigation of the properties of an electron gas in intense magnetic fields. We have obtained expressions for the thermodynamic energy density, particle density, the magnetic moment, and pair density (created in equilibrium with the system) for a gas of electrons with an anomalous magnetic moment, using the exact eigenvalues of the Dirac-Pauli equation for an electron with an anomalous magnetic moment, obtained by Ternov *et al.* According to the solution of Ternov *et al.*, the lowest energy states of the electrons can be zero at certain field strengths. We have shown that pair creation does not occur spontaneously at the expense of the magnetic-field energy, but only at the expense of the thermodynamic energy of other particles of the system. Exact expressions for the pair density are given.

## Separated Two-Component Equations for Spin-$\frac{1}{2}$ Particles Using Foldy-Wouthuysen-Type Transformations with an Application to the $\mathbf{k}\cdot\mathbf{p}$ Method in Solids

S. TEITLER
*Naval Research Laboratory, Washington, D. C. 20390*
(Received 26 February 1968)
44.1
62.6 p. 1443

The Foldy-Wouthuysen formalism is presented in a representation-independent manner. It is shown that an algebraic transformation serves to remove the mass term from the Dirac equation for spin-$\frac{1}{2}$ particles, thereby providing decoupled two-component equations in a particular (Weyl) representation. Also it is shown that appropriate use of a constant algebraic transformation applied to a Dirac Hamiltonian in the usual (Pauli) representation leads to a nonrelativistic $\mathbf{k}\cdot\mathbf{p}$ equation used in solid-state theory for which the $\mathbf{k}$-dependent spin-orbit term is absent.

spectively. In respective order, the resonance laboratory energies are 14.918±0.006, 15.716±0.010, 16.336 ±0.015, 16.496±0.008, 16.965±0.014, 17.430±0.010, and 17.476±0.010 MeV.

usual (Pauli) representation leads to a nonrelativistic $\mathbf{k}\cdot\mathbf{p}$ equation used in solid-state theory for which the k-dependent spin-orbit term is absent.



## Multipole Particles in Equilibrium in General Relativity*

P. Szekeres
*Department of Mathematics, King's College, Strand, London, W.C.2*
(Received 9 July 1968)
61.6 p. 1446

Axially symmetric static solutions of Einstein's equations with singularities on the $z$ axis are considered. The structure of the singularities is more general than that considered previously by Bergmann, since higher multipole moments are now allowed. The equilibrium conditions for such multipole singularities in an external field are derived. It is shown that solutions having two or more such singularities on the axis may be found in abundance, independently of the signs of the masses of the particles.

## Distribution of Blackbody Cavity Radiation in a Moving Frame of Reference*

G. R. Henry, R. B. Feduniak, J. E. Silver,† and M. A. Peterson‡
*Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305*
61.4 (Received 16 August 1968)
62.2 p. 1451
62.4

Blackbody cavity radiation is considered from the point of view of an observer in arbitrary uniform motion with respect to the c.m. of the radiation. It is found that the only effect of the motion is to introduce an angle-dependent effective temperature, which replaces the rest-frame temperature of the cavity. The results are applied to the question of the earth's motion through the 3°K cosmic radiation.

## Emission of Radiation from a System of Many Excited Atoms*

V. Ernst† and P. Stehle
*Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15213*
23 (Received 19 May 1967; revised manuscript received 3 June 1968)
62.4 p. 1456
62.8

The Weisskopf-Wigner theory of the natural linewidth of a single isolated atom is extended to a system of $N(\gg 1)$ identical nonoverlapping atoms which are all in the same excited state at time $t=0$. The positions $\mathbf{X}_1\cdots\mathbf{X}_N$ of the atoms are assumed to fill a volume $\mathcal{V}$ of given shape and size with macroscopically constant density. Emission of radiation from this system takes place only in the form of one narrow, but nonzero-width, bundle of nearly equal photons, which contains all the emitted radiation. If the density of atoms within $\mathcal{V}$ exceeds a certain threshold, the rate of emission of photons has the form of a typical spike. All effects depend sensitively on the shape and size of $\mathcal{V}$ and on the density of atoms within $\mathcal{V}$, and cannot be explained in conventional terms of spontaneous or stimulated emission of radiation.

## Exactly Soluble Nonrelativistic Model of Particles with Both Electric and Magnetic Charges

Daniel Zwanziger*
*Department of Physics, New York University, New York 10012*
62.8 (Received 25 July 1968)
64.4 p. 1480
66.2

We consider the quantum-mechanical problem of the interaction of two particles, each with arbitrary electric and magnetic charges. It is shown that if an additional $1/r^2$ potential, of appropriate strength, acts between the particles, then the resulting Hamiltonian possesses the same higher symmetry as the nonrelativistic Coulomb problem. The bound-state energies and the scattering phase shifts are determined by an algebraic and gauge-independent method. If the electric and magnetic coupling parameters are $\alpha$ and $\mu=0, \pm\frac{1}{2}, \pm 1, \cdots$, then the bound states correspond to the representations $n_1+n_2=|\mu|, |\mu|+1, \cdots, n_1-n_2=\mu$ of $SU_4\otimes SU_2\sim O_6$, and the scattering states correspond to the representations of $SL(2,C)\sim O(1,3)$ specified by $\mathbf{J}^2-\mathbf{K}^2=\mu^2-\alpha'^2-1$, $\mathbf{J}\cdot\mathbf{K}=\alpha'\mu$, with $\alpha'=\alpha/v$. Thus, as $\alpha$ and $\mu$ are varied, all irreducible representations of $O_4$ and all irreducible representations in the principal series of $O(1,3)$ occur. The scattering matrix is expressed in closed form, and the differential cross section agrees with its classical value. Some results are obtained which are valid in a relativistic quantum field theory. The $S$ matrix for spinless particles is found to transform under rotations like a $\mu \to -\mu$ helicity-flip amplitude, which contradicts the popular assumption that scattering states transform like the product of free-particle states. It is seen that the Dirac charge quantization condition means that electromagnetic interactions are characterized not by one but by two, and only two, free parameters: the electronic charge $e\approx(137)^{-1/2}$, and the electric charge of the magnetic monopole, whose absolute magnitude is not fixed by the Dirac quantization condition but which defines a second elementary quantum of electric charge.

## Quantum Field Theory of Particles with Both Electric and Magnetic Charges*

Daniel Zwanziger†
*Department of Physics, New York University, N. Y., New York 10012*
(Received 5 August 1968)
62.8 p. 1489

The quantum field theory of particles with both electric and magnetic charges is developed as an obvious extension of Schwinger's quantum field theory of particles with either electric or magnetic charge. Two new results immediately follow. The first is the chiral equivalence theorem which states the unitary equivalence of the Hamiltonians describing the system of particles with electric and magnetic charges $e_a$, $g_a$ and the system with charges $e_a'=\cos\theta\ e_a+\sin\theta\ g_a$, $g_a'=-\sin\theta\ e_a+\cos\theta\ g_a$. This result holds in particular in the absence of physical magnetic charges. The second result is that if physical magnetic charges do occur, then, in consequence of chiral equivalence, the charge quantization condition applies, not to the separate products $e_mg_n$, but to the combinations $e_mg_n-g_me_n$, which must be integral multiples of $4\pi$. The general solution of this condition leads to the introduction of a second elementary quantum of electric charge $e_2$, the electric charge on the Dirac monopole, besides the first elementary charge $e_1$, the charge on the electron. There are no other free parameters.

## Relative Proton Number in Neutron Star Matter

J. Nemeth
*Department of Theoretical Physics, Eotvos University, Budapest, Hungary*
and
Donald W. L. Sprung
*Physics Department, McMaster University, Hamilton, Ontario, Canada*
51.4 (Received 27 May 1968)
61.4 p. 1496

The energy density of neutron star matter is determined from Brueckner-theory calculations of nuclear matter and the pure neutron gas. Three-body clusters are assumed to contribute negligibly to the nuclear energy, according to the theory of Bethe. The relative density of protons, determined by minimizing the total energy, is found to increase with increasing matter density. In addition, we find that muons would appear at about half the normal nuclear density.

## Inverse Compton Effect and Universal 3°K Radiation

LUDWIG OSTER

*Joint Institute for Laboratory Astrophysics and Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80302*

61.2 (Received 19 January 1968; revised manuscript received 23 August 1968)
61.4 p. 1501

The production of photons with energies in the range where at present the 3° blackbody radiation is observed from less energetic radio photons of galactic and metagalactic origin is investigated. It is shown that this process cannot contribute significantly to the observed intensity. At an earlier stage of the development of the universe, Compton events were probably much more frequent. However, since under plausible assumptions on the energy distribution of cosmic-ray electrons Compton scatterings do not produce a blackbody spectrum, our results can be used to establish an upper limit for the density of relativistic electrons and radio photons at the time of original galaxy formation.

## Search for Cosmic Gamma Radiation in the Southern Sky*

J. G. DUTHIE AND R. W. OSBORN†

*Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627*

61.2 (Received 16 August 1968)
61.4 p. 1505

A balloon-borne spark chamber was flown over western Queensland on 26 November 1966 in an attempt to detect cosmic photons of energy greater than 100 MeV emanating from several celestial objects of interest. No sources were found, and upper limits in agreement with those set by other observers were obtained.

## Static, Axially Symmetric Point Horizons*

JEFFREY WINICOUR,† ALLEN I. JANIS, AND EZRA T. NEWMAN

*University of Pittsburgh, Pittsburgh, Pennsylvania 15213*

(Received 25 July 1968)
61.6 p. 1507

Properties of event horizons are examined for static, axially symmetric, vacuum space-times. Israel has shown that under fairly general conditions such horizons are singular. One would expect that a positive-mass point particle would correspond to a pointlike singular horizon. It is shown, however, that the horizons *cannot* be pointlike. The geometry of particular horizons is discussed.

## Relativistic Center-of-Mass Variables for Two-Particle Systems with Spin

HUGH OSBORN

*School of Mathematical and Physical Sciences, University of Sussex, Brighton, England*

62.2 (Received 25 April 1968)
62.6 p. 1514

The definition of the total momentum, position, and spin for Galilean- or Lorentz-invariant two-free-particle systems is discussed by using the requirement that the generators of the respective invariance groups should have the same form expressed in terms of them as for a single particle. Internal c.m. dynamical variables are introduced by applying the singular transformation due to Gartenhaus and Schwartz on the basic single-particle dynamical variables, the transformation mapping the whole Hilbert space onto the c.m. subspace spanned by states of zero total momentum. The form of the internal c.m. position operator is given for particles with spin, for what appears to be the first time. Using these dynamical variables, it is shown how an interaction can be introduced while maintaining Galilean or Lorentz invariance and satisfying the asymptotic condition of freely propagating particles for large separations.

## Relativistic Corrections to Nonrelativistic Two-Particle Dynamical Calculations: Demonstration of the Validity of the Drell-Hearn-Gerasimov Sum Rule for Weakly Bound Composite Particles

HUGH OSBORN

*School of Mathematical and Physical Sciences, University of Sussex, Brighton, England*

(Received 25 April 1968)
64.4 p. 1523

The problem of the first-order relativistic corrections to the conventional nonrelativistic perturbation treatment of electromagnetic interactions of bound states is discussed. It is shown how the Thomas precession effect is usually mishandled for small excitation energies acting on a bound state. These results are demonstrated by the explicit calculation of the single-particle matrix elements of the charge density and the low-energy Compton scattering amplitude in a simple bound-state model. The amplitudes, which are known by virtue of relativistic invariance and current conservation, are also explicitly calculated, but agreement is obtained only by applying the relativistic modifications of the c.m. variables found in a previous paper. At the same time, the Drell-Hearn-Gerasimov sum rule is shown to be consistent for this model and also for simple models of the hydrogen atom and the deuteron when the constituent particles have arbitrary masses.

## Density Matrices in the Many-Body Problem

P. GLUCK

33 *Department of Mathematical Physics, The University of Birmingham, Birmingham, 15, England**

41.1 (Received 10 July 1968)
62.6 p. 1534

The problem of correlations is considered in many-fermion systems, although with some modifications the methods are more general. The many-body problem is formulated in terms of reduced one- and two-particle density matrices, and the equations for these are treated by variational and iterative methods. The formalism is applied to a calculation of the energy per particle for a system interacting with Coulomb, screened Coulomb, and singular potentials. Comparisons with the ideas of Brueckner and others are made, and difficulties are discussed.

## Maximum Number of Binary Collisions for Three Relativistic Point Particles

G. DOOLEN*

*NASA-Goddard Space Flight Center, Greenbelt, Maryland 20771*

62.2 (Received 22 July 1968)
65 p. 1541

As a step toward understanding relativistic rescattering singularities, we examine $n_{max}$, the maximum number of binary collisions allowed by special relativity among three particles with zero-range forces. We find that for three equal-mass particles $n_{max}=3$. However, for three particles with masses $m_1=m_3=1$ and $m_2<1$, $n_{max}$ decreases with increasing total energy $W$ from its nonrelativistic value, which is between $\infty$ and 4, to its final value of 4, when $W>1/m_2$.

should have the same form expressed in terms of them as for a single particle. Internal c.m. dynamical variables are introduced by applying the singular transformation due to Gartenhaus and Schwartz on the basic

and that for three equal-mass particles $n_{max}=3$. However, for three particles with masses $m_1=m_2=1$ and $m_3<1$, $n_{max}$ decreases with increasing total energy $W$ from its nonrelativistic value, which is between $\infty$ and 4, to its final value of 4, when $W>1/m_3$.



## Exact Solution for the Scattering of Electromagnetic Waves from Conductors of Arbitrary Shape. II. General Case*†

VICTOR A. ERMA
*Astrophysics Research Corporation, Los Angeles, California 90024*
(Received 8 August 1968)

62.4 p. 1544

The perturbation-expansion technique developed earlier for the scattering of plane electromagnetic waves from cylindrically symmetric conductors is here generalized to an arbitrary radiation field incident on a conductor of entirely arbitrary shape. The analytical solution obtained is exact, inasmuch as no approximations, either of a mathematical or physical nature, were introduced. It is thus equally valid in the near and far zones, as well as over the entire frequency range, including the resonance region. Two separate analytical forms of the solution are obtained, and several special cases are considered in detail. The form of the solution is particularly well suited for methodical numerical evaluation by machine calculation.

## Changes of the Petrov Type of a Space-Time

LLOYD A. CASE*
*Brigham Young University, Provo, Utah*
(Received 12 August 1968)

61.6 p. 1554

A theoretical study is made of the "evolution" of a space-time of one Petrov type into another. The word "evolution" is used to mean that change of type which a point observer would consider his local space-time had experienced as a discontinuous front swept over him. The study is motivated by a desire to better understand the Petrov classification and thus improve its use as a tool to deal with solutions in general relativity. An algorithm is developed that may in principle be used to test the evolution of any closed-form solution known. A flow diagram is found which shows the routes that each Petrov type may use and the Petrov type of the discontinuity causing each change. During this development some results of the study of discontinuous hypersurfaces are found essentially equivalent to Trautman's information approach to waves, thus yielding further motivation for the use of the latter. The Weyl technique is understood as an important method for at least partially separating the coordinate and physical behaviors.

## A Path Integral for Spin*

LAWRENCE SCHULMAN
*Physics Department, Indiana University, Bloomington, Indiana 47401*

62.6
66
(Received 1 August 1968)
66.2 p. 1558

A path integral for spinning particles is developed. It is a one-particle theory, equivalent to the usual quantum mechanics. Our method employs a classical model for spin which is quantized by path integration. The model, the spherical top, is a natural one from a group-theoretic point of view and has been used before in a similar context. The curvature and multiple connectedness of the top coordinate space $[SO(3)]$ provide some interesting features in the sum over paths. The Green's function which results from this procedure propagates all spins, and recovery of the usual Pauli spinors from this formalism is achieved by projection to a specific spin subspace.

## Trajectory and Mass Shift of a Classical Electron in a Radiation Pulse*

JOSEPH H. EBERLY AND ARTHUR SLEEPER†
*Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627*
(Received 21 August 1968)

62.4 p. 1570

We solve the Hamilton-Jacobi equations of motion of a classical charge in the presence of a traveling pulse of electromagnetic radiation. The orbit solutions for arbitrary radiation pulse shape are given in terms of one-dimensional integrals, and for a particular choice of singly peaked pulse shape are given in detail as a function of the particle's proper time. The question of the particle mass is then investigated, and an expression for the classical interacting mass is given as an explicit function of the time width of the radiation pulse. The average shift in the square of the mass, $\Delta m^2$, varies smoothly from zero to a maximum and then to zero again as the pulse overtakes and passes the charged particle. The maximum value is $\Delta m^2=\frac{1}{2}e^2a^2$ (where $e$ and $a$ are the particle charge and the field amplitude). We conclude that for the free-electron–photon scattering experiments currently being contemplated at optical frequencies the maximum figure is likely to be the relevant one.

## $\pi^-p\to\pi^-\pi^0p$ Reaction at 2.77 GeV/$c$ for Low Momentum Transfers to the Proton

J. P. BATON AND G. LAURENS
*Département de Physique des Particules Elémentaires, Centre d'Etudes Nucléaires, Saclay, France*
(Received 1 March 1968)

63.8 p. 1574

The reaction $\pi^-p\to\pi^-\pi^0p$ produced by 2.77-GeV/$c$ pions has been studied for low squared four-momentum transfers to the proton ($\Delta^2\leqslant 13\mu^2$). A selection based on a fast premeasurement method has allowed the accumulation of high statistics (7666 events) and a detailed study of the $\rho^-$ properties. In particular, the $\rho^-$ mass and width are determined as a function of $\Delta^2$, showing essentially no variation of these parameters in the whole $\Delta^2$ range. On the other hand, the mass and width values deduced from the mass spectra ($\omega_r=773\pm2$ MeV, $\Gamma_r=150\pm5$ MeV) differ from the corresponding values for the resonant $P$ wave ($\omega_r=755\pm5$ MeV, $\Gamma_r=110\pm9$ MeV) obtained by extrapolation to the pion pole, following the Chew-Low method. Essential results on the $\pi^-\pi^0$ elastic cross section are summarized. The sensitivity of the determination of the $\rho^-$ production and decay parameters to various mass and $\Delta^2$ cuts is shown.

## $K^*(890)$ and $K^*(1420)$ Production in $K^-p$ Interactions at 4.57 BeV/$c$†

Y. W. KANG‡
*Institute for Atomic Research and Department of Physics, Iowa State University, Ames, Iowa 50010*
(Received 10 June 1968)

63.8 p. 1587

A study of three-body final states produced in 2-prong $K^-p$ interactions at 4.57 BeV/$c$ is presented on the basis of 10 500 GUTS-fitted events. Abundant production of $K^*(890)$ is observed in all three final states ($K^-\pi^+n$, $\pi^-p\bar{K}^0$, and $K^-p\pi^0$), while $K^*(1420)$ is more copiously produced in the final state $K^-\pi^+n$ than in the others. The spin density matrix elements for the $K^*(890)$ and $K^*(1420)$ are given and the production mechanisms are discussed in terms of the one-meson-exchange model. The cross sections for $K^*(890)$ and $K^*(1420)$ are given.

## Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/$c$

A. FRIDMAN
*Département de Physique Corpusculaire, Centre de Recherches Nucléa res de Strasbourg, Strasbourg, France*
*and*
*Institut für Hochenenergiephysik, der Universität Heidelberg, Heidelberg, Germany*
AND
G. MAURER, A. MICHALON, J. OUDET, R. STRUB, C. VOLTOLINI, AND P. CÜER
*Département de Physique Corpusculaire, Centre de Recherches Nucléaires de Strasbourg, Strasbourg, France*
(Received 26 June 1968)
63.6 p. 1595

Appreciable angular correlations between pions have been observed for both $\bar{p}+p \to 4\pi^+ + 4\pi^-$ and $\bar{p}+p \to 4\pi^+ + 4\pi^- + \pi^0$ reactions. Deviation between the angular correlation predicted by the phase-space calculations and our experimental values seems to occur for definite-momentum configurations of the produced pions. The secondaries are not emitted in a jet structure, i.e., the transverse and c.m. longitudinal momentum of the pions are in satisfactory agreement with phase predictions. By comparing the results of this experiment with other $\bar{p}p$ data, some systematics seem to emerge for the angular distribution of secondary pions.

## Muon Polarization in $K_{\mu 3}{}^0$-Meson Decay*

R. J. ABRAMS,**† A. ABASHIAN, R. E. MISCHKE,‡ B. M. K. NEFKENS,§
J. H. SMITH, R. C. THATCHER,|| L. J. VERHEY,§ and A. WATTENBERG
*Department of Physics, University of Illinois, Urbana, Illinois 61801*
(Received 13 August 1968)
63.2 p. 1603

The polarization of the muon in the decay $K_L{}^0 \to \pi^- \mu^+ \nu$ was measured in a spark-chamber experiment. For the decay phase space measured in this experiment, the results are $\alpha P_L = 0.31 \pm 0.07$, $\alpha P_T = -0.02 \pm 0.07$, and $\alpha P_P = -0.10 \pm 0.07$, where $P_L$, $P_T$, and $P_P$ are the average components of polarization along the muon momentum, transverse to the decay plane, and perpendicular to the muon in the decay plane. The analyzing parameter $\alpha$ of the muon decay is about 0.35 in this experiment. From the above polarization results, assuming energy-independent form factors, we obtain the ratio of form factors $\xi = f_-/f_+$; the results are $\mathrm{Re}\xi = -1.6 \pm 0.5$ and $\mathrm{Im}\xi = -0.2 \pm 0.6$.

## Relativistic Energy Loss by Ionization in Nuclear Emulsions

F. J. CONGEL* AND P. J. MCNULTY
*Physics Department, Clarkson College of Technology, Potsdam, New York 13676*
27
(Received 1 July 1968)
63.4 p. 1615

The variation in grain density in the tracks of 5-, 8-, 12-, and 24-GeV/$c$ protons and 5-GeV/$c$ pions has been investigated as a function of velocity in the same plate of an Ilford K-5 nuclear emulsion. About 80 000 blobs were counted for each beam. The pion-to-proton ratio of grain densities at 5 GeV/$c$ is $1.114 \pm 0.006$. The results are in agreement with the Sternheimer formula using a mean ionization potential for AgBr of 434 eV and a cutoff energy $T_0$ of 2–5 keV. Comparison of these data with an earlier experiment in a G-5 emulsion shows no dependence of the rate of the relativistic rise in grain density on type of emulsion. The combined data from the two experiments are in excellent agreement with Sternheimer's formula with $I = 434$ eV and $T_0 = 5$ keV with no correction due to secondary ionization. A correction for secondary ionization corresponding to a 10% contribution due to secondary ionization at minimum ionization gives excellent agreement with $I = 434$ eV and $T_0 = 2$ keV.

## $\bar{K}^0$ and $\Lambda^0$ Production in $K^- + p$ Interactions at 7.7 GeV/$c$*

A. BUFFINGTON† AND C. E. W. WARD‡
*Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139*
(Received 2 July 1968)
63.8 p. 1621

This article reports the results of a spark-chamber measurement of the reactions $K^- + p \to \bar{K}^0 +$neutrals and $K^- + p \to \Lambda^0 +$neutrals with an incident kaon momentum of 7.7 GeV/$c$. The production cross sections for these reactions are measured to be $800 \pm 50$ $\mu$b and $188 \pm 18$ $\mu$b, respectively. The cross-section distributions $d^2\sigma/dP_{11}dP_1$ in the center-of-mass system with large momentum transfer are discussed in terms of a fireball model of production.

## Charge-Exchange $K^- + p \to \bar{K}^0 + n$ at 7.7GeV/$c$*

A. BUFFINGTON,† D. H. FRISCH, AND C. E. W. WARD‡
*Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139*
(Received 2 July 1968)
63.8 p. 1628

The results of a spark-chamber measurement of the reaction $K^- + p \to \bar{K}^0 + n$ at an incident kaon momentum of 7.7 GeV/$c$ are reported. The cross section is measured to be $71 \pm 13$ $\mu$b.

## Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium*

J. L. ALBERI, J. A. APPEL,† R. J. BUDNITZ,‡ J. CHEN, J. R. DUNNING, JR., M. GOITEIN,§
K. HANSON, D. C. IMRIE,|| C. A. MISTRETTA,** AND RICHARD WILSON
*Harvard University, Cambridge, Massachusetts 01451*
(Received 30 July 1968)
63.4 p. 1631

The energy spectrum of electrons inelastically scattered at 20° lab from deuterium has been measured for an incident electron energy of 1578 MeV. The virtual photon cross section has two peaks at mass values corresponding to the $\Delta(1236)$ and $N'(1525)$ resonances. No peak was observed in the mass region of the $N'(1470)$ Roper resonance. The upper limit for the contribution of the Roper resonance to the virtual photon cross section is estimated to be 120 $\mu$b.

## Search for Stable Fractionally Charged Particles*

DAVID M. RANK†
*University of Michigan, Ann Arbor, Michigan*
(Received 18 March 1968)
63 p. 1635

A search for stable quarks in terrestrial materials has been carried out using ultraviolet spectroscopy and an oil-drop technique of charge measurement. The spectroscopy involved a search for the Lyman series of emission lines from hydrogenic atoms formed with a $+\frac{2}{3}$ quark as a nucleus. The oil-drop method attempted to detect $\frac{1}{3}$ integral charges on oil drops approximately 20 $\mu$ in diam. Electric fields were used to enrich the samples in quarks and thereby improve the sensitivity of the experiments. The concentration of quarks in the materials examined was determined to be less than $10^{-18}$ quarks/nucleon for the spectroscopic experiments and less than $10^{-20}$ quarks/nucleon for the oil-drop experiments.

agreement with $f=434$ eV and $T_0=2$ keV.

of quarks in the materials examined was determined to be less than $10^{-18}$ quarks/nucleon for the spectroscopic experiments and less than $10^{-20}$ quarks/nucleon for the oil-drop experiments.



## Search for the Contribution of the Longitudinal Virtual Photon in Inelastic Electron-Proton Scattering

PAUL BOUNIN*
*Service de Physique Nucléaire à Haute Energie, Centre d'Etudes Nucléaires de Saclay, France*
(Received 25 July 1968)
63.4 p. 1643

We have made a systematic investigation of the inelastic scattering cross section for electrons on hydrogen, keeping constant the two relativistic parameters: four-momentum transfer $q^2$ and equivalent photon energy $K$. In the one-photon-exchange approximation, it is then possible to separate the contributions due to the longitudinal and transverse virtual photons. The new feature of our experiment was the use of a thin (12-mm) flat hydrogen target. For our choice of the parameters [$q^2=0.2$, 0.3, and 0.4 (BeV/$c$)$^2$; $K=340$ MeV] we did not find any discernible contribution of the longitudinal virtual photon.

## $K^-p$ Elastic Scattering at 4.6 GeV/$c$*

L. S. SCHROEDER, R. A. LEACOCK, R. L. WAGSTAFF, AND W. J. KERNAN
*Institute for Atomic Research and Department of Physics, Iowa State University, Ames, Iowa 50010*
(Received 2 August 1968)
63.8 p. 1648

$K^-p$ elastic scattering at 4.6 GeV/$c$ is studied with a sample of approximately 2000 bubble chamber events. The elastic cross section is found to be $\sigma_{el}=4.2\pm0.3$ mb, and $\sigma_{el}/\sigma_{tot}=0.168\pm0.017$. The value of the forward differential cross section is consistent with zero real part of the scattering amplitude. No backward scattering events are observed. The Regge-pole model of Phillips and Rarita gives a reasonable fit to the data.

## Compilation of $\pi^-p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering*†

P. B. JOHNSON, J. A. POIRIER, N. N. BISWAS, N. M. CASON, T. H. GROVES, V. P. KENNEY, J. T. MCGAHAN, AND W. D. SHEPHARD
*Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556*

AND

L. J. GUTAY, J. H. CAMPBELL, R. L. EISNER, F. J. LOEFFLER, R. E. PETERS, R. J. SAHNI, AND W. L. YEN
*Department of Physics, Purdue University, Lafayette, Indiana 47907*

AND

I. DERADO AND Z. G. T. GUIRAGOSSIÁN
*Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305*
63.8
64.7
64.8
(Received 26 July 1968)
p. 1651

In $\pi^-p$ single-pion-production reactions near 4 GeV/$c$, we observe several interesting features. Backward $\rho^0$ production is seen to occur with $d\sigma/du=63\pm21$ $\mu$b/(GeV/$c$)$^2$ at 180°. Backward $\rho^-$ production is less prominent. We see evidence for production at small $u$ of $N^{*0}$ ($p\pi^-$ near 1700 MeV) and $\Delta^-$ ($n\pi^-$ at 1236 MeV), and possible evidence for other $n\pi^-$ structure at about 1800 MeV. The density-matrix elements for peripheral $\rho^0$ production are presented in the Jackson and in the helicity frame. The $\pi^+\pi^-$ elastic cross section is obtained by extrapolation of the data to the mass shell. The $S$-wave $\pi\pi$ phase shifts are calculated by two methods and compared with previous results. We find evidence in the dipion decay angular distribution for the $\pi^+\pi^-$ decay mode of the $S^*(1070)$.

## Experimental Tests of Cascade Theory at High Energies*

R. HOLYNSKI† AND W. V. JONES‡
*Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803*

AND

K. PINKAU
*Max-Planck-Institut für Extraterrestrische Physik, Garching bei München, Germany*
(Received 1 July 1968)
61.2
63.4 p. 1661

Results of simultaneous measurement of the radial position and angular orientation of electrons in ten high-energy (180–2000-BeV) electromagnetic cascades are given. Six of these cascades were developed in pure emulsion, while four were developed in a lead-emulsion sandwich stack. Numerical calculations of the angular distributions, both within approximation B and the core approximation, are presented. Calculations on the mixed radial-angular distribution are related to the separate distributions. A method is given for the use of the mixed distribution to extend the effective radial range of measurement to such an extent that the transition of the experimental results from the core approximation to approximation B becomes evident. Limited experimental verification of the often-used approximation B is thereby established. It is further shown that cascade theory is internally consistent within the region of validity of the core approximation and that the radial range must extend up to $\sim10^{-1}$ radiation length in order to include all particles having angles as small as $\sim$4–5 deg.

## Low-Energy Theorems for $e^4$ Compton Scattering Amplitudes

T. P. CHENG
*The Rockefeller University, New York, New York 10021*
64.4
66.2
(Received 2 August 1968)
p. 1674

Unitarity and fixed-momentum-transfer dispersion relations are used to evaluate the contribution to the $e^4$ Compton amplitude from the intermediate state of target plus soft photon. It is found that the leading term goes like $\omega^3\ln\omega$ for scattering of photons of low frequency ($\omega$) by either spin-0 or spin-$\frac{1}{2}$ targets. The $e^4$ amplitudes up to this order ($\omega^3\ln\omega$) are shown to be structure-independent as a consequence of the usual Compton-scattering low-energy theorems, which have been proven rigorously only in order $e^2$.

## Nuclear Effects on the Quasi-Elastic Neutrino Scattering $\nu+n\rightarrow\mu^-+p$†

YORK-PENG YAO
*Randall Laboratory of Physics, University of Michigan, Ann Arbor, Michigan 48104*
(Received 21 August 1968)
51.6
64.2 p. 1680

We have assumed a Fermi-gas model to account for the nuclear effects in the process $\nu+n\rightarrow\mu^-+p$. Various expressions for differential cross sections are derived as analytically as possible to bring out the physical features. The formulation is then used to analyze the preliminary Argonne data. The mass parameter $M_A{}^2$ in a dipole fit of the axial-vector form factor of the nucleon is found to be $0.7m_p{}^2$–$0.9m_p{}^2$.

## Theories at Infinite Momentum*†

K. BARDAKCI‡ AND M. B. HALPERN
*Department of Physics and Lawrence Radiation Laboratory, University of California, Berkeley, California 94720*

62.6
62.8
65.5

(Received 25 July 1968)

p. 1686

We construct Galilean-invariant theories (with Schrödinger equations) at infinite momentum that describe interacting relativistic systems. Classes of both first- and second-quantized theories are presented. The formalism provides a general approach to the saturation of current algebra; positivity of the mass spectrum is guaranteed, and as much inelasticity as necessary may be introduced. More generally, however, such theories offer the hope of potential-theoretic intuition for relativistic physics.

## Simultaneous Partial-Wave Expansion in the Mandelstam Variables: The Group $SU(3)$

A. P. BALACHANDRAN*
*International Centre for Theoretical Physics, Trieste, Italy, and Physics Department, Syracuse University, Syracuse, New York,*
AND
W. J. MEGGS*
*Physics Department, Syracuse University, Syracuse, New York,*
AND
J. NUYTS
*Laboratoire de Physique Théorique et Hautes Energies, 91 Orsay, France,*
AND
P. RAMOND†
*Physics Department, Syracuse University, Syracuse, New York*

64.6
65
66.4

(Received 1 July 1968)

p. 1700

The elastic scattering amplitude of two spinless particles of equal mass $\frac{1}{2}$ was expanded elsewhere in a double series of eigenfunctions which "displayed" its dependence on all the Mandelstam variables $s$, $t$, $u$ ($s+t+u=1$). The expansion was then used to investigate the crossing properties of partial-wave amplitudes. We show in this paper that these eigenfunctions are certain basis vectors of the representations $(\sigma,\sigma)$ of a suitably defined $SU(3)$. The unequal-mass problem is also discussed.

## Scalar Density Terms, $K\pi$ and $KK$ Scattering Lengths, and a Symmetry-Breaking Parameter*

RICHARD W. GRIFFITH
*California Institute of Technology, Pasadena, California 91109*

64.7
66.4

(Received 12 August 1968)

p. 1705

An estimation of $s$-wave $K\pi$ and $KK$ scattering lengths is made, and a discussion is given of the relation of these quantities to scalar density matrix elements and the relevant symmetry-breaking parameter.

## Interference, Mixing, and Angular Correlations in Decays of Boson Resonances*

HARRY J. LIPKIN†
*Palmer Physical Laboratory, Princeton University, Princeton, New Jersey*

64.7
66.4

(Received 17 June 1968)

p. 1709

Two new features of boson resonances are discussed. (1) Interference and mixing in decays of different bosons having common decay channels, and (2) competition between partial-wave amplitudes when more than one is allowed. Several examples are considered. Interference between $f^0 \to K\bar{K}$ and $A_2^0 \to K\bar{K}$ is discussed. The axial-vector nonets are discussed in detail, as well as the application to higher-spin resonances.

## *CP* Violation and Coherent Decays of Kaon Pairs*

HARRY J. LIPKIN†
*Palmer Physical Laboratory, Princeton University, Princeton, New Jersey*

64.2
66.2

(Received 11 June 1968)

p. 1715

The possible experimental use of correlations between two neutral-kaon decays is discussed. Kaon pairs produced either in proton-antiproton annihilation from an $s$ state or in $\varphi$ decay are in a $p$ wave, which is forbidden by Bose statistics for identical bosons. The observance of a particular decay mode, i.e., $\pi^+\pi^-$, for one kaon implies that the other kaon is forbidden to decay at the same time in this mode. Thus a kaon beam can be constructed that is just that coherent linear combination of $K_S$ and $K_L$ whose amplitudes for decay into this mode cancel one another. The existence of $\Delta I = \frac{3}{2}$ transitions leading to the $I=2$ final state in $K^0$ decay can be tested by looking for double decays where one of the kaons decays into $\pi^+\pi^-$ and the other into $\pi^0\pi^0$. This double decay is allowed at the same time only if both $\Delta I = \frac{1}{2}$ and $\Delta I = \frac{3}{2}$ amplitudes are present in the kaon decay. Detailed calculations and experimental implications are discussed.

## Possible Classification of Exchange-Degenerate Trajectories*

AKBAR AHMADZADEH AND RICHARD J. JACOB
*Department of Physics, Arizona State University, Tempe, Arizona 85281*

64.7
66

(Received 26 June 1968)

p. 1719

A possible classification of nearly all the known mesons in terms of exchange-degenerate trajectories is given. This classification is consistent with the quark model and is also in general agreement with the behavior of the trajectories inferred from high-energy phenomenology. Predictions are made for the quantum numbers of some resonances. Arguments for the Lorentz-pole classification of these trajectories are also given.

An estimation of $s$-wave $K\pi$ and $KK$ scattering lengths is made, and a discussion is given of the relation of these quantities to scalar density matrix elements and the relevant symmetry-breaking parameter.

numbers of some resonances. Arguments for the Lorentz-pole classification of these trajectories are also given.



## Nucleon-Nucleon Models, Charge Splitting, and the Nucleon-Nucleon Data near 210 MeV*

M. D. Miller and P. S. Signell
*Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48823*
and
N. R. Yoder
*Department of Physics, University of Maryland, College Park, Maryland 20742*
(Received 26 August 1968)
52.6 63.6 64.9 p. 1724

Phase-shift analyses have been made of the nucleon-nucleon scattering data near 210 MeV. Several nuclear potential models are compared with the results and are found to be clearly distinguishable by differences in their isospin-singlet phase shifts, particularly by the coupling parameter $\epsilon_1$ which is of importance for nuclear physics. There is no evidence of charge splitting in the $^1S_0$ state.

## Upper and Lower Bounds on Scattering Lengths for Static Potentials

A. M. Arthurs
*Department of Mathematics, University of York, York, England*
(Received 17 June 1968; revised manuscript received 22 August 1968)
65 p. 1730

New upper and lower bounds on scattering lengths for static potentials are presented. The derivation is based on complementary variational principles for Fredholm integral equations of the type $\rho(r)\varphi(r) = f(r) - \int K(r,r')\varphi(r')dr'$ with symmetric, positive-definite kernels.

## Can the Parity of the $\Omega^-$ Be Measured?*

G. L. Kane
*Physics Department, University of Michigan, Ann Arbor, Michigan 48104*
and
Michael J. Moravcsik
*Institute of Theoretical Science and Department of Physics, University of Oregon, Eugene, Oregon 97403*
(Received 29 April 1968)
64.2 64.8 p. 1733

The $\Omega^-$ is unusual in that it can only decay weakly, and in that, for purposes of measuring its parity, it can only be produced in reactions with (at least) three-body final states. These circumstances imply that, with one possible exception, it may be so difficult to measure the parity of the $\Omega^-$ that such a measurement is a practical impossibility for some time to come.

## Structure in $\eta$, $K \to 3\pi$ Decay

Brian G. Kenny
*Rutherford High Energy Laboratory Chilton, Didcot, Berkshire, United Kingdom*
(Received 17 September 1968)
64.2 p. 1735

We explore some of the consequences of the linear matrix-element and linear spectrum approximations in the decays $\eta$, $K \to 3\pi$. The problem is considered both nonrelativistically and relativistically, assuming that all pions have equal mass. In particular, we examine two different consequences. First, we consider the different implications of the different models for the differential energy spectra. Secondly, we find that by taking various simple linear combinations of the Dalitz-plot sextants and comparing them, it is possible to make certain "consistency predictions" which are different for the two different models considered and which would enable one to distinguish between the models in a very simple way.

## Regge Secondary Trajectories

G. C. Fox* and L. Sertorio
*Institute for Advanced Study, Princeton, New Jersey 08540*
(Received 8 July 1968)
65.5 p. 1739

A systematic study of isospin-one exchange reactions leads to the proposal of additional singularities in the $j$ plane of this channel. Such an analysis gives rise to several extra predictions to be tested in future experiments.

## Representation Mixing and $SU_3$ Symmetry Breaking in the $\frac{1}{2}^-$ Baryon Octet*

Peter N. Dobson, Jr.
*University of Hawaii, Honolulu, Hawaii 96822*
(Received 24 July 1968)
64.8 66.4 p. 1757

Widths and coupling-constant products are obtained for members of the $\frac{1}{2}^-$ baryon resonance octet by fitting the $\eta$-production data near threshold with a direct-channel resonance model. An interpretation of the fitted parameters in terms of representation mixing is shown to lead to large singlet-octet and decuplet-octet mixing. Quark-model modifications of the vertices, as proposed by Mitra and Ross, are also considered, with much the same results. An alternative interpretation in terms of an $SU_3$ symmetry-breaking interaction based on a suggestion by Pakvasa is given.

## Two-Pion-Exchange Contributions to Nucleon-Nucleon Scattering*

W. R. Wortman†
*Department of Physics, Texas A&M University, College Station, Texas 77843*
(Received 6 June 1968)
64.9 p. 1762

Contributions to $N$-$N$ phase shifts are found, using Feynman diagrams through fourth order in the coupling constant in pseudoscalar-meson theory. The amplitudes are evaluated using Cutkosky's method to express them in dispersion-relation form, and geometric unitarization is applied to calculate phase shifts. In addition to pion and nucleon intermediate states, particles in the baryon and psuedoscalar octets are allowed, subject to $SU_3$ symmetry. The results indicate that there are features of the phase shifts, particularly in higher partial waves, that are due to two-pion-exchange effects. The addition of the $SU_3$-restricted intermediate states gives no improvement.

## Equivalent-Potential Approach Using the Bethe-Salpeter and Unitarity Equations*

LOUIS A. P. BALÁZS†
*Department of Physics, University of California, Los Angeles, California 90024*

64.6
64.7
(Received 29 July 1968)
p. 1769

A Bethe-Salpeter potential is defined which will reproduce the absorptive part at each energy. The method is a straightforward generalization of the one originally proposed by Charap and Fubini for defining the correct nonrelativistic potential. It is, however, fully relativistic and does not seem to lead to spurious singularities. In practice, an approximate version of the potential is used—one which gives only long-range effects correctly. In addition, the absorptive part is assumed to be dominated by a few narrow resonances; a discussion is given of the differences between such an equivalent potential and a potential given by perturbation theory. The method is applied to a rough calculation of the $\rho$ meson in $\pi\pi$ scattering with the potential constructed from $\rho$, $f^0$, and $g$ meson exchange. Experimental values are taken for their masses as well as for the input $\rho$ and $f^0$ widths. The input $g$-meson width (which is least well known experimentally) is then adjusted so that the output $\rho$ has the correct mass. This leads to widths of 222 and 175 MeV for the input $g$ and output $\rho$ (compared with experimental values of 170±30 and 125 MeV, respectively). Finally, a purely on-shell technique is discussed which is very similar to the Bethe-Salpeter scheme but may avoid some of its difficulties.

## Photon Scattering from Bound Atomic Systems at Very High Energy*

M. L. GOLDBERGER
*Palmer Physical Laboratory, Princeton, New Jersey 08540*
AND
F. E. LOW
*Institute for Advanced Study, Princeton, New Jersey† 08540*

14
65.5
(Received 7 August 1968)
p. 1778

The elastic scattering of photons from bound atomic systems is studied in the limit of infinitely high energy. It is found that the amplitude differs significantly from the free-particle value when the binding is strong. Explicit formulas for a spin-0 particle bound in a $1/r$ potential (both world-scalar and Coulomb) are obtained as well as power series in the coupling strength for a spin-$\frac{1}{2}$ target. The general result in the latter case is reduced to quadratures.

## Kinematic Singularity Structure of Amplitudes for a Four-Particle Process with One Massless Particle*

S. R. COSSLETT
*Cavendish Laboratory, Cambridge, England*

65
(Received 23 May 1968)
p. 1782

For a two-to-two particle interaction, one of the particles being massless, we discuss and give the kinematic-singularity-free combinations of helicity amplitudes, the constraint equations, and an expression for invariant amplitudes in terms of helicity amplitudes. The constraint equations are obtained from an invariant-amplitude expansion rather than from the crossing matrix.

## Factorization, Kinematic Singularities, and Conspiracies

FARZAM ARBAB AND J. D. JACKSON
*Department of Physics and Lawrence Radiation Laboratory, University of California, Berkeley, California 94720*

64.6
65.5
(Received 26 July 1968)
p. 1796

Factorization of residues of poles of the $S$ matrix is derived from the requirements of unitarity for partial-wave helicity amplitudes. Careful attention is given to questions of spin and the kinematic singularities of the relevant amplitudes, especially at $t=0$. Residues $\beta$ of a pole in the full partial-wave amplitude satisfy factorization in the simple form $\beta_{bc}{}^{J}=\beta_{ac}\beta_{bb}$. In general, $\beta$ can be written as $\beta=K\gamma$, where $K$ contains the standard kinematic singularities of the Hara-Wang type, plus threshold behavior, and $\gamma$ is a reduced residue. The $K$'s for various mass classes are exhibited in a compact and consistent form, and the corresponding factorization statements for the reduced residues are derived. These factorization relations are of the form $I^{x}\gamma_{bc}{}^{J}=\gamma_{ac}\gamma_{bb}$, where $x$ is an integer. The reduced residues are analytic in the neighborhood of thresholds and pseudothresholds, but may, in the case of conspiracies, contain poles at $t=0$. Various examples are presented to illustrate the use of factorization. These include LeBellac's argument on the behavior of the pion residue at $t=0$ and its circumvention with a type-II conspiracy. Mandelstam's treatment of Adler's self-consistency condition and the hypothesis of partially conserved axial-vector current using an $M=1$ pion is discussed from the viewpoint of factorization. It is shown that factorization for an $M=1$ pion seems to imply smallness of both soft-pion and hard-pion amplitudes. The smallness of the latter casts some doubt on the $M=1$ assignment for the pion. The nature of the relations between amplitudes and the behavior of the reduced residues at $t=0$ for conspiracies with unequal masses is also considered.

## Decays of Odd-Parity Baryon Resonances*

J. C. CARTER
*Loyola University, New Orleans, Louisiana 70118*
AND
M. E. M. HEAD†
*Tulane University, New Orleans, Louisiana*

64.2
64.8
66.4
(Received 6 August 1968)
p. 1808

Baryon members of the three-quark $SU(6)$ **70** and **56** are coupled with a vector spurion assigned to the $1^{3}$ of an $SU(6)$ **35** to form odd-parity baryon resonances. Branching ratios for decays are calculated using the relativistic techniques of $SU(6)_{W}$ and are compared with experiment. The $N_{1}^{*}(1518)$ and $Y_{1}^{*}(1660)$ are assigned to an $8^{4}\subset 1^{3}\otimes 8^{3}$ of $\mathbf{35}\otimes\mathbf{70}$. Observed branching ratios indicate that the decays proceed through the **70** channel as Capps has predicted. The $Y_{1}^{*}(1765)$, $Y_{0}^{*}(1830)$, and $\Xi_{1}^{*}(1935)$ are assigned to an $8^{4}\subset 1^{3}\otimes 8^{1}$ of $\mathbf{35}\otimes\mathbf{70}$. Missing members of these multiplets are discussed and branching ratios given. Decay amplitudes for other possible multiplets are stated.

## Chiral Lagrangian Calculation of Pion-Nucleon Scattering Lengths*

R. D. PECCEI
*Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139*

62.8
64.8
66.4
(Received 23 July 1968; revised manuscript received 23 September 1968)
p. 1812

We have considered two chiral-invariant Lagrangian models of pion-nucleon scattering: Weinberg's model, which contains a direct pion-nucleon scattering term; and an extension of Schwinger's model in which this direct term is replaced by a $\rho$-mediated term. These models have been extended by including a $\pi NN^{*}(1236)$ interaction. This has allowed us to calculate the $N^{*}$ contributions to the $S$-wave pion-nucleon scattering

kinematic-singularity-free combinations of helicity amplitudes, the constraint equations, and an expression for invariant amplitudes in terms of helicity amplitudes. The constraint equations are obtained from an invariant-amplitude expansion rather than from the crossing matrix.

direct term is replaced by a $\rho$-mediated term. These models have been extended by including a $\pi NN^*(1236)$ interaction. This has allowed us to calculate the $N^*$ contributions to the $S$-wave pion-nucleon scattering



lengths and to compute the $P$-wave scattering lengths. The theoretically obtained values for these scattering lengths are found to be in reasonable agreement with experiment, with the possible exception of the $a^-_{P1/2}$ scattering length, for which only the direct model gives agreement with the present experimental data. For the $a_{S^+}$ scattering length, agreement was obtained only after the introduction of a contact term. The presence of such a term is made more plausible by the study of the asymptotic behavior of the isospin-even amplitudes. We have also compared our analysis with similar current-algebra calculations and obtain over-all agreement, especially with the $\rho$-exchange model, although we differ from these calculations in various details.

## Conspiracy and Counterconspiracy in Equal-Mass Scattering*

J. H. Weis†
*Lawrence Radiation Laboratory, University of California, Berkeley, California 94720*
(Received 26 August 1968)
65.5 p. 1822

Group theory provides an elegant general solution of the equal-mass conspiracy conditions but leaves open the possibility of a "counterconspiracy" between a number of integrally spaced Lorentz poles. It is shown that factorization of Regge-pole residues and coupling to channels of arbitrarily high spin imply that only one counterconspiracy (consisting of an infinite number of Regge poles) is possible in equal-mass scattering. It is also shown that, if there is coupling to unequal-mass channels, then even this counterconspiracy is forbidden and the only possible solution is for the equal-mass channel residues to be those of a single Lorentz pole.

## Complex $\bar{K}N$ Scattering Lengths and Current Algebra

Debabrata Basu, S. N. Biswas, and K. Datta
*Centre for Advanced Study in Physics, Department of Physics and Astrophysics, University of Delhi, Delhi 7, India*
64.8
66.4
(Received 12 August 1968)
p. 1835

We calculate the real and imaginary parts of the $s$-wave $\bar{K}N$ scattering length in the $I=0$ channel, starting from the predictions of soft-meson current algebra. The multichannel $ND^{-1}$ formalism is used to unitarize the amplitudes obtained from current algebra. We isolate dynamical off-mass-shell corrections in certain residues for one-pole approximations to the numerator functions. These residues, for which we make assumptions of smooth extrapolation, are obtained by comparing the unitarized amplitudes with the results of current algebra. The coupling of the $\bar{K}N$ to the $\pi\Sigma$ channel, which has a lower threshold, generates the imaginary part of the scattering length with the correct sign and reverses the (incorrect) sign of the real part. The magnitudes of the real and imaginary parts agree well with the results of recent experiments and are consistent with the existence of the $Y_0^*(1405)$ virtual bound state below the $\bar{K}N$ threshold.

## Relation of Charged-$K$ Decay to $CP$ Violation

Robert M. Delaney
*Department of Physics, Saint Louis University, St. Louis, Missouri 63103*
and
Daniel J. Welling
*Department of Physics, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201*
64.2
66.2
(Received 26 August 1968)
p. 1841

An $SU(3)$ model is described which relates the rate of the charged-$K$ decay $K^+ \to \pi^+ + \pi^0$ to the magnitude of $CP$ violation. A weak-interaction Lagrangian for nonleptonic processes is constructed from octet currents in a Cabibbo frame under the hypothesis that the $CP$-conserving processes are described predominantly by an octet-dominant interaction Lagrangian, and that the $CP$-violating processes enter solely through the 27-dimensional representation of $8\otimes 8$. Three types of octet currents are used: $L_\mu$, which is linear in the field operators, and $J_\mu$ and $K_\mu$, which are bilinear and possess opposite $C$-transformation properties. It is shown that if only $I=2$ contributions enter into the 27 portion of the Lagrangian, then, approximating $|K_S\rangle$ and $|K_L\rangle$ by the $CP$ eigenstates $|K_1\rangle$ and $|K_2\rangle$, the observed rate of the charged-$K$ decay and $\theta=0.26$ for the Cabibbo angle fix $|\eta_{+-}|=5.38\times10^{-3}$ and $|\eta_{00}|=3.12\times10^{-3}$, of the proper order of magnitude. Introducing the experimentally observed departure of $|K_S\rangle$ and $|K_L\rangle$ from $CP$ eigenstates and a renormalization constant for the $K$ current yields $|\eta_{+-}|=1.97\times10^{-3}$ and $|\eta_{00}|=2.92\times10^{-3}$, in good agreement with experiment.

## Model for Leptonic Interactions. II. Is the Pion the Intermediate Boson?

Christian Fronsdal
*International Centre for Theoretical Physics, Prosecco-Miramare 21 34100 Trieste, Italy*
(Received 27 August 1968)
64.2 p. 1846

A suggestion by Schwinger to use a scalar boson as mediator of weak interactions is combined with a proposal by Nishijima to consider the weak interactions as second-order effects of an interaction with no first-order manifestations. It is then possible to identify the intermediate boson with the pion, although the existence of another spinless boson as an intermediary for weak interactions cannot be ruled out. In either case there is no resonance in high-energy neutrino scattering. If the interaction Lagrangian is odd under $PC$, then observable $PC$ violation will occur in the third order, with qualitatively correct strength provided that the bosom has strong interactions.

## Intersecting Regge Trajectories in a Field-Theory Model*

Arthur R. Swift
*Physics Department, University of Massachusetts, Amherst, Massachusetts 01002*
(Received 8 August 1968)
62.8
65.5 p. 1848

The intersection of Regge trajectories in a field-theory model is investigated by means of high-energy perturbation-theory techniques. For a repulsive interaction, one of the three trajectories present in the pure ladder-diagram model near $l=-2$ intersects the pole originating at $l=-1$ and forms a conjugate pair of poles in a manner similar to that previously found in potential theory. When additional relativistic diagrams are mixed with the ladder diagrams, two of the secondary trajectories can intersect, encircle $l=-1$, and reach the physical region while the leading pole remains real and below $l=-1$.

## Off- and On-Shell Analyticity of Three-Particle Scattering Amplitudes*

D. D. Brayshaw†
*Rockefeller University, New York, New York*
(Received 12 July 1968)
65 p. 1855

Off-shell analytic properties are obtained for amplitudes which satisfy approximate three-body equations of the Faddeev-Lovelace type. These properties are used to construct an explicit representation for the off-shell three-particle amplitude in terms of the solution of a new integral equation. The advantages of this new equation for both analytical and computational purposes are discussed, and the representation is used to determine on-shell analyticity for the amplitude. The form of the representation is such that the important three-body singularities are exhibited in a particularly transparent fashion.

## Divergent Part of the Second-Order Electromagnetic Corrections to the Ratio $G_A/G_V$

A. SIRLIN*
*International Atomic Energy Agency, International Center for Theoretical Physics, Miramare, Trieste, Italy*
64.2 64.4 64.6 (Received 27 August 1968) p. 1871

The divergent part of the second-order electromagnetic corrections to the axial-vector matrix elements is studied. The main tool in this work is a simple extension of the Bjorken limit to the case involving the time-ordered product of three currents (or local operators.) Applying this generalization to theories in which all gradient terms are assumed to be $c$ numbers, one finds, in the *over-all* corrections to the axial-vector matrix elements, logarithmic divergences which are not present (to the same approximation in $\alpha$) in the Fermi amplitude. These divergences give a vanishing contribution if a relevant double commutator involves only a $\delta$ function and if the commutator $[\partial_0 j^\mu(\mathbf{x}), j_\mu(0)]$ is a $c$ number, $j^\mu$ being the hadronic part of the electromagnetic current. If these two conditions hold, one can show, for example, that the second-order corrections to $G_A/G_V$ (in neutron $\beta$ decay) are finite in the simple intermediate-boson model previously discussed. In the usual case in which $[\partial_0 j^\mu(\mathbf{x}), j_\mu(0)]$ is an operator, one finds, in general, uncompensated logarithmic divergences in the *over-all* corrections to $G_A/G_V$ with coefficients which appear to be highly model-dependent. The effect of operator gradient terms and the possible connection with the well-known divergences in the electromagnetic mass shifts is discussed. The case of the $SU_3 \otimes SU_3$ algebra of fields is studied separately. Applying the generalization of the Bjorken limit, it is easy to identify in this theory the part of the (divergent) radiative corrections to $\beta$ decay which is associated with the mass shifts of the charged vector and axial-vector mesons. After this part is removed by a mass renormalization of such mesons, the remaining divergences maintain the chiral structure, are independent of momentum transfer, and amount to one-half the Bjorken correction factor. Thus, by applying the method of this paper, one readily recovers, in the case of the algebra of fields, Schwinger's interpretation of this factor, as well as his expressions for the divergent parts of the mass shifts of the charged vector and axial-vector mesons. It is pointed out that, in the broader context of current algebra, such identifications are model-dependent. This is illustrated by examining, on the basis of the approach of this work, the familiar example of muon decay.

## Effect of the Existence of an Elementary Quark on High-Energy Scattering*†

STUART D. ANDERSON
*Lawrence Radiation Laboratory, University of California, Berkeley, California 94720*
(Received 3 June 1968)
64.6 65.5 p. 1881

An elementary quark, if supposed to exist and to couple in quark-antiquark pairs to ordinary two-particle channels, gives rise to a Regge trajectory which would dominate high-energy scattering at large momentum transfer. A simple model theory embodying these features is presented. Specifically, the model assumes a single scalar-scalar pair to represent the ordinary two-particle channel which is observed, coupled to a spinor-spinor channel of large mass, and simple pole-type potentials approximated in the effective-range method. The Regge trajectory and subtraction generated by this coupling are computed, and arguments are given concerning their contribution to the cross section. Comparison with proton-proton scattering suggests that if such an elementary particle exists, its mass must be greater than about 10 GeV.

## Model Dependence of the Asymptotic Behavior of Form Factors for Relativistic Composite Models

M. CIAFALONI*
*Scuola Normale Superiore, Pisa, Italy*
*and*
*Istituto Nazionale di Fisica Nucleare, Sezione di Pisa, Italy*
64.8 66.4 (Received 12 July 1968) p. 1891

The large-momentum-transfer behavior of the electromagnetic form factors of composite hadrons is shown to be model-dependent. Integer-spin bound states are treated in the ladder approximation to the two-body Bethe-Salpeter equation. Both spinless and spin-$\frac{1}{2}$ constituents are considered, interacting through regular or singular renormalizable interactions. It is found that the asymptotic behavior of the form factors depends on the kind of singularity at the origin for the regular interactions and on the coupling constant for the singular ones. This dependence is different for spinless and spin-$\frac{1}{2}$ constituents. For spinless constituents, the form factor vanishes more rapidly than $1/q^2$ in all significant cases, but for spin-$\frac{1}{2}$ constituents it does not; in all cases, however, it vanishes at infinity, and the behavior is better than in the corresponding elementary-particle case.

## Rescattering Effects in the Quark Model for Meson-Baryon Couplings

J. D. ANAND, V. S. BHASIN, AND A. N. MITRA
*Department of Physics, University of Delhi, Delhi-7, India*
62.8 64.4 (Received 8 July 1968) p. 1898

The eikonal approximation in high-energy scattering is used as a basis for the evaluation of scattering corrections to meson-baryon couplings in the independent quark model. These corrections, which reduce the $SU(6)$ symmetry (characteristic of the impulse approximation) to a mere $SU(3)$ symmetry, are found to be typically of the order of 20–30% on the coupling constants. An important part of the correction, which arises from the purely "$SU(3)$-isotropic" component of the meson-quark amplitude, has exactly the same structure as the $SU(6)$-invariant couplings and hence can be interpreted as a renormalization effect. The remaining corrections, which may be called the "true scattering effects," lead to an explicit formula for the $F/D$ ratio in octet couplings in terms of the meson-quark scattering parameters which differs from its $SU(6)$ value of $\frac{3}{4}$ by about 4%. These corrections also give an enhancement factor for decuplet decays which increases the predicted rate for $N^* \to N\pi$ by about 30%. It is argued that the nature of these numerical results is rather insensitive to the precise validity or lack of validity of the eikonal approximation.

## Bootstrap of Meson Trajectories from Superconvergence

M. ADEMOLLO*†
*Lyman Laboratory, Harvard University, Cambridge, Massachusetts*
AND
H. R. RUBINSTEIN,‡ G. VENEZIANO,§ AND M. A. VIRASORO‖
*Department of Nuclear Physics, Weismann Institute of Science, Rehovot, Israel*
64.6 64.7 65.5 (Received 14 June 1968) p. 1904

In this paper we study the reactions $\pi\pi \to \pi\omega(1^-)$, $\pi\pi \to \pi A_2(2^+)$, and $\pi\pi \to \pi\omega_3(3^-)$ as a bootstrap system for natural-parity trajectories. We start from the solution of our previous work that gave, among other results, expressions for the trajectory and residue functions as well as mass formulas, in agreement with experiment. Here we study in detail the sum rules as a function of momentum transfer $t$. We find a set of residue functions $\beta(t)$ that are self-consistent and such that the Regge and resonance sides of the equations are almost equal in a large region of $t$. We study also a step-by-step approximation that, at each stage,

method. The Regge trajectory and subtraction generated by this coupling are computed, and arguments are given concerning their contribution to the cross section. Comparison with proton-proton scattering suggests that if such an elementary particle exists, its mass must be greater than about 10 GeV.

with experiment. Here we study in detail the sum rules as a function of momentum transfer $t$. We find a set of residue functions $\beta(t)$ that are self-consistent and such that the Regge and resonance sides of the equations are almost equal in a large region of $t$. We study also a step-by-step approximation that, at each stage,



enlarges the region where the equations are valid. We find, however, that the leading Regge trajectories, even if infinitely rising, cannot bootstrap themselves. We outline two possible (not incompatible) ways of implementing the bootstrap. The first way demands an optimized choice of the cutoff parameter and considers the whole family of reactions $\pi\pi \to \pi X_J$ ($X_J$ being a normal-parity state of spin $J$). Our results for $J \leq 3$ show that this is a definite possibility. The second way is to consider a whole family (parent and daughters) as participating in the bootstrap. We find this possibility also attractive, and as a consequence we find that daughters must be parallel to the parent, for linear trajectories. The properties of our parametrization are also discussed—in particular, the Khuri paradox and the coupling of high-spin resonances to the system. We also compare our results with experiment whenever possible. Our $A_2$ trajectory, for instance, follows the Gell-Mann mechanism, and the exponential $t$ dependence of our residue functions is perfectly consistent with the one found in recent phenomenological fits to inelastic reactions.

## Meson Bootstraps for Unnatural-Parity States

M. Bishari, H. R. Rubinstein, A. Schwimmer, and G. Veneziano
*Weizmann Institute of Science, Rehovot, Israel*

64.7 (Received 17 May 1968)
66.4 p. 1926

In this paper we study the possibility of bootstrapping the unnatural-parity meson states, using finite-energy sum rules. Previous work on this bootstrap scheme was confined to natural-parity states. We find a large number of sum rules involving particles which are not firmly established, with results that are in good agreement with experiment (10%). The equations, though not mathematically consistent, are such that the two sides (Regge and resonances) are equal when $t$ is varied over a large region, and we find several mass formulas, including $m_H^2 = 2m_\rho^2 - \frac{1}{2}m_\epsilon^2$, $m_B = m_{A_2} - m_\epsilon$, $2m_B^2 = 0.5$ BeV$^2 + 2m_\delta^2 + m_\omega^2 + m_\epsilon^2$, and relations between coupling constants.

## Interacting Rarita-Schwinger Field

Gyan Mohan
*Department of Physics, University of Denver, Denver, Colorado 80210*

62.8 (Received 23 October 1967)
65.5 p. 1931

To avoid the mutual inconsistency between interaction, quantization, and subsidiary conditions of the Rarita-Schwinger spin-$\frac{1}{2}$ field, an additional subsidiary field is introduced in the spirit of the Stückelberg formalism. Relativity is violated in the time development of the subsidiary field, but no observable consequences seem to follow. The unwanted states are removed invariantly from the asymptotic states through a Gupta-Bleuler kind of subsidiary condition. Energy has a positive-definite expectation value in the physical states.

## Unitarity-Analyticity Equations for Elastic Pion-Nucleon Scattering: A Numerical Solution

John R. Boccio
*Swarthmore College, Swarthmore, Pennsylvania 19081*

64.6 (Received 1 August 1968)
64.8 p. 1934

Using the elastic unitarity approximation together with Mandelstam analyticity and the crossing principle, an approximation scheme has been devised within the framework of the elastic pion-nucleon scattering problem. A set of four coupled linear integral equations for the imaginary parts of the $u$-channel absorptive parts has been constructed. Regge asymptotic behavior has been assumed. A crude numerical analysis of the equations has been carried out. The results were very encouraging in that output trajectories were produced which rise to values of $\mathrm{Re}\alpha_\Delta(u) \approx \frac{1}{2}$ and possess a shape which resembles the conventionally assumed form.

## A $\lambda\varphi^4$ Quantum Field Theory without Cutoffs. I

James Glimm*
*Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139*
and
Arthur Jaffe†
*Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138*

(Received 20 May 1968)
62.8 p. 1945

We construct the dynamics for a local quantum field theory in two-dimensional space-time. Our model describes a scalar field $\varphi$ with a $\lambda\varphi^4$ self-interaction. We rely upon the fact that, in the Heisenberg picture, influence propagates at the speed of light. The resulting dynamics is independent of any cutoff, and hence the theory is formally Lorentz-covariant.

## Argand-Diagram Loops and Regge Poles

P. D. B. Collins, R. C. Johnson,* and G. G. Ross*
*Physics Department, University of Durham, Durham City, England*

64.6
64.8 (Received 9 August 1968)
65.5 p. 1952

We examine the way in which a crossed-channel Regge pole can produce loops in the Argand diagrams of direct-channel partial waves. It is shown that combinations of trajectories can produce loops which rotate in either direction when the energy is increased. It is argued that these loops do not correspond to resonance poles, but are the effect of oscillations of the crossed-channel discontinuity on the partial-wave amplitudes. We examine the partial-wave projections of Regge fits to $\pi^\pm p$, $K^\pm p$, $pp$, and $p\bar{p}$, and find loops in all these processes, including $K^+p$ and $pp$, which are not known to have any resonances. It is concluded that the existence of these loops should make one cautious about interpreting all the loops found in recent $\pi N$ phase-shift analyses as resonance poles.

## $K_{l4}$ Form Factors in Current Algebra with Hard Pions and Kaon

A. Q. Sarker*
*International Centre for Theoretical Physics, Trieste, Italy*
*and*
*Institute of Physics, University of Islamabad, Rawalpindi, Pakistan*

64.2 (Received 8 August 1968)
66.2 p. 1959

The axial form factors in $K_{l4}$ decays are calculated using the technique of current algebra, hard kaon and pions, the assumption of partially conserved axial-vector current, and the spectral-function sum rules. The assumption of meson dominance of certain vertex functions and inverse propagators as given by Schnitzer and Weinberg is inherent in such calculations. Taking the parameter $\xi$ from the experimental $K_{l3}$ decays and using the predicted axial-vector form factors at their zero arguments, the decay rates for $K^+ \to \pi^+\pi^-e^+\nu$ and $K^+ \to \pi^+\pi^-\mu^+\nu$ are then calculated. On comparison with their recent observed rates, it is found that the value $\xi_{\mathrm{br}} = 0.6$ (from the branching ratio) is strongly favored, as opposed to $\xi_{\mathrm{pol}} = -1.0$ (from polarization measurements). The values of the form factors for other $K_{l4}$ decays are also given.

## Current Algebra and the Vector Form Factor in $K_{l4}$ Decays

A. Q. Sarker*
*International Centre for Theoretical Physics, Trieste, Italy*
*and*
*Institute of Physics, University of Islamabad, Rawalpindi, Pakistan*
(Received 8 August 1968)
64.2
66.2
p. 1971

The vector form factor in $K_{l4}$ decays is expressed in terms of the known decay rate $\pi^0 \to 2\gamma$, using the technique of current algebra, hard pions and kaon, and the assumption of partially conserved axial-vector current. Its contributions to the various $K_{l4}$ decay rates are then calculated and its largest value is found to be about 2% that of the axial-vector rate in the case of $K^+ \to \pi^+\pi^-e^+\nu$ decay.

## Study of the Decays $K \to l\bar{l}$ and $K \to \pi l\bar{l}$

A. Pais
*Rockefeller University, New York, New York 10021*
AND
S. B. Treiman
*Palmer Physical Laboratory, Princeton University, Princeton, New Jersey 08540*
64.2
64.4
66.2
(Received 7 August 1968)
p. 1974

A general discussion is presented of polarization and angular distributions in the decays $K \to l\bar{l}$ and $K \to \pi l\bar{l}$. Our main motivation is to examine the ways in which such distributions may reveal the influence of higher-order weak effects as distinct from electromagnetic effects. We focus on the relatively most favorable case of the $K_L$ modes. Under the neglect of the small $CP$ impurity in the composition of $K_L$ and $K_S$ states, and of electromagnetic final-state interactions, these modes provide interesting tests for $CP$ and $CPT$ invariance in hitherto unexplored dynamical situations.

## Scalar Nonet, Semileptonic $K$ Decays, and Spectral-Function Sum Rules

Binayak DuttaRoy* and Alexander Martin†
*Stevens Institute of Technology, Castle Point Station, Hoboken, New Jersey 07030*
(Revised 19 July 1968)
64.2
66.2
p. 1979

In this paper we show that if one takes $\epsilon(700)$, the broad isoscalar $s$-wave dipion resonance for which there exists considerable evidence, along with the as yet not firmly established $\eta_V(1071)$ and $\pi_V(1016)$ and a $K_V$ (perhaps the one at 1080), as forming a scalar nonet, then the widths and branching ratio for the decay of these resonances into two pseudoscalar mesons are quite consistent with observation. In addition, the mixing of $\epsilon$ and $\eta_V$ explains the puzzling smallness of the branching ratio $(\eta_V \to \pi\pi)/(\eta_V \to K\bar{K})$, and simultaneously accounts for the $K_{s4}$ axial-vector form factors. Finally, these scalar resonances are found to fit quite well in the framework of current algebra and spectral-function sum rules stemming from $SU(3)\otimes SU(3)$ symmetry.

## Three-Body Interaction Effects in High-Energy Scattering from Deuterons

David R. Harrington
*Department of Physics, The State University of Rutgers, New Brunswick, New Jersey 08903*
(Received 9 July 1968)
52.6
64.9
65
p. 1982

Corrections to the Glauber multiple-scattering expansion due to three-body interactions are studied. The particular interaction considered corresponds to the scattering of an incident particle from a pion being exchanged by the two nucleons composing a deuteron. It is shown that the resulting correction to the scattering amplitude must be modified to take into account the possibility of absorption on the nucleons. A crude numerical estimate indicates corrections of about $-0.4\%$ to the total cross section at very high energy. The effect on the differential cross section at large momentum transfer is difficult to estimate reliably, but the formulas obtained suggest that the corrections could become quite important unless there is a strong off-shell damping mechanism.

## Regge Asymptotic Behavior and the Bethe-Salpeter Equation

Richard A. Brandt* and Martin Feinroth†
*Center for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742*
(Received 25 July 1968)
62.8
65.5
p. 1985

Making certain assumptions, we directly take the limit of the Bethe-Salpeter equation at high energy ($s$) for the elastic scattering amplitude $A(s,t)$ in $g\phi^3$ theory. For a large class of planar kernels behaving like $I(t)s^{-q}(\ln s)^p$, with integer $p \geq 0$ and $q \geq 1$, we obtain a Volterra equation for the asymptotic amplitude. The unique solution is of the Regge form $s^{\alpha(t)}$, with $\alpha(t) = -q + [p!K_q(t)I(t)]^{1/(p+1)}$. Here $K_q$ is an explicit function, independent of $g$. This result agrees with that obtained by summation of leading asymptotic behaviors in each order of perturbation theory in all known cases. We explicitly justify our assumptions for the ladder approximation. In this case we obtain an integral equation for the exact $\alpha(t)$ which agrees with the usual result to order $g^2$. We conclude with a discussion of nonplanar kernels in our formalism.

## $K^*(890)$ Photoproduction in the Regge-Pole Model†

N. S. Thornber‡
*Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305*
64.4
64.8
65.5
(Received 10 June 1968; revised manuscript received 16 September 1968)
p. 1998

In this paper the Regge-pole model is applied to $K^*(890)$ photoproduction. Conspiracy relations, kinematic constraints, factorization, and the question of when to set $m_\gamma = 0$ are discussed. Predictions are obtained, in the limit of large $s$ and small $t$, for $d\sigma/d\Omega$, the density matrix, and the $K^*$-decay angular distribution.

accounts for the $K_{e4}$ axial-vector form factors. Finally, these scalar resonances are found to fit quite well in the framework of current algebra and spectral-function sum rules stemming from $SU(3)\otimes SU(3)$ symmetry.

tained, in the limit of large $s$ and small $t$, for $d\sigma/d\Omega$, the density matrix, and the $K^*$-decay angular distribution.



## Multi-Reggeon Behavior of Production Amplitudes

I. T. Drummond
*Department of Applied Mathematics and Theoretical Physics, University of Cambridge, England*
64.6 (Received 24 April 1968; revised manuscript received 16 July 1968)
65.5 p. 2003

Gribov's approach is used to investigate the asymptotic properties of production amplitudes. When it is applied to an analysis of double Reggeon exchange, the results of previous authors are confirmed. In particular, it is verified that the amplitude $f_{\alpha_1\alpha_2}$ for the coupling of two Reggeons, $\alpha_1$ and $\alpha_2$, to a particle (of mass $M$) depends not only on the masses $q_1'^2$ and $q_2'^2$ of the Reggeons, but also on $q_3'^2=(q_1'-q_2')^2$. (Primed vectors are spacelike and perpendicular to the incident beam.) On the basis of a diagrammatic model, the dependence of $f_{\alpha_1\alpha_2}$ on $q_3'^2$ is elucidated. When $M=m_\pi$, a strong variation of $f_{\alpha_1\alpha_2}$ throughout the physical region is expected. The same approach is applied to an analysis of a Reggeon triangle graph. Gribov's rules are found to apply provided that certain extra factors are included in the integrand. Because of these factors, the Reggeon "Ward identity" suggested by Anselm and Dyatlov no longer holds. The analytic structure of the corresponding double partial-wave amplitude is investigated. It has ordinary two-Reggeon singularities in each angular momentum separately, together with a leading curve depending on both variables. For the triangle graph, it turns out that the leading curve determines the asymptotic behavior, which is of the form $s^J/\ln s$, where the exponent $J$ depends on $q_3'^2$ as well as on $q_1'^2$ and $q_2'^2$. This type of behavior has no analog in two-body scattering, and it would be of interest to identify such behavior experimentally. Finally, it is pointed out that underlying the definition of the approximate double partial wave used in this paper is the asymptotic simplicity of analytic structure in energy variables of the production amplitude.

## Two-Boson-Exchange Effects in Nucleon-Nucleon Scattering

Richard D. Haracz
*Drexel Institute of Technology, Philadelphia, Pennsylvania 19104*
and
Ravi D. Sharma*
*Temple University, Philadelphia, Pennsylvania*
(Received 17 June 1968)
64.9 p. 2013

The two-pion-exchange contribution to nucleon-nucleon scattering is studied at scattering energies of 95 and 310 MeV through a partial-wave analysis of the exact relativistic scattering matrix. Additional two-boson-exchange effects are also studied at these energies corresponding to the $\pi+\eta$ and $\pi+\sigma$ exchange processes, with $\eta$ the pseudoscalar resonance and $\sigma$ the scalar resonance. It is found that the two-pion-exchange (TPE) phase parameters are large compared with one-pion-exchange (OPE) phase parameters for low values of $L$, and OPE+TPE is a reasonable representation of the phenomenological phases for the lower energy when $L\geq 3$ and for the higher energy when $L\geq 5$. The $\pi+\eta$ effect is found to be small compared with the pion-theoretical effects, but the $\pi+\sigma$ effect is large for a light scalar resonance if it couples strongly with the nucleon.

## Currents as Dynamical Variables*

Charles M. Sommerfield
*Sloane Physics Laboratory, Yale University, New Haven, Connecticut 06520*
62.8
64.6 (Received 19 July 1968)
66.4 p. 2019

A dynamical theory of currents is presented. For each current there are a complete set of field equations and a complete set of equal-time commutators. These are related by expressing the energy-momentum tensor solely in terms of the currents and not of derivatives of the currents. The requirements of Lorentz covariance place severe restrictions on the commutators. Several models with and without internal symmetry are discussed.

## Sums of Direct-Channel Regge-Pole Contributions and Crossing Symmetry*

N. N. Khuri†
*Lawrence Radiation Laboratory, University of California, Berkeley, California 94720*
*and*
*Rockefeller Univeristy, New York, New York 10021*
(Received 28 August 1968)
65.5 p. 2026

Starting with a sequence of parallel rising trajectories in the $s$ channel, we give examples of residue functions for which the Regge-Mandelstam pole contributions can be explicitly summed. The sum has Regge behavior in the $s$ channel as well as the $t$ channel, and satisfies fixed-$t$ dispersion relations and finite-energy sum rules. The residue functions we start with do satisfy the usual analyticity properties and threshold properties, have the Mandelstam symmetry factor, and show the expected exponential behavior for large $|s|$. These results are achieved without fixing either the slope or the intercept of the leading trajectory and without specifying $\mathrm{Im}\alpha$ in detail in the low- and intermediate-energy region. We use these examples to clarify some of the problems related to the use of finite-energy sum rules, both as phenomenological relations and as dynamical equations. The way a finite but large number of $s$-channel resonances can be summed to give Regge behavior in $s$ is explicitly demonstrated. We also indicate how the observation by Schmid on the relation of the $\rho$-exchange contribution in pion-nucleon charge-exchange scattering to direct-channel resonances can be understood in terms of a direct-channel Regge-Mandelstam analysis. Finally, we point out a general method for generating more examples of other residue functions with the desired properties.

## Cancellation of Divergences in Reggeized Electromagnetic Mass Differences*

Arnulf Rabl
*Lawrence Radiation Laboratory and Department of Physics, University of California, Berkeley, California 94720*
64.4
64.6 (Received 2 August 1968)
65.5 p. 2034

By use of Regge theory and the Cottingham formula, the divergences of electromagnetic mass differences are isolated in Minkowski space. Sum rules are derived which are necessary and sufficient to remove them; they also turn out to be the necessary and sufficient conditions for the Wick rotation to Euclidean space via $q_0\rightarrow iq_0$. Bjorken's argument for logarithmic divergences due to current algebra is extended to the case where subtractions are needed in the dispersion relations. The connection between the divergence, the commutator $[[j_\mu(0,\mathbf{x}),H],j^\mu(0)]$, and the fixed pole at $J=0$ is clarified. The asymptotic value of the fixed-pole residue is found in terms of this commutator.

## Model of High-Energy Meson Photoproduction*

T. T. Chou
*Institute for Theoretical Physics, State University of New York, Stony Brook, New York 11790*
64.4
64.6 (Received 7 June 1968)
p. 2041

A modified coherent-droplet model for high-energy meson photoproduction is presented. Results are found to be in very good agreement with presently available experimental data of $\rho$, $\pi$, and $K$ production.

## Connection between the Toller Quantum Number $M$ and the Small-$t$ Behavior of the Asymptotic $S$-Channel Helicity Amplitudes*

JOHN F. GUNION AND H. M. LIPINSKI
*Department of Physics, University of California, San Diego, La Jolla, California*
64.6 65.5 66.4
(Received 19 August 1968)
p. 2045

Using a group-theoretic decomposition of the scattering amplitude, we show that the quantum number $M$ introduced to ensure factorization of the asymptotic $s$-channel helicity amplitudes is precisely the Toller quantum number.

## $O(4)$ Expansion of Off-Shell Scattering Amplitudes*

W. R. FRAZER, F. R. HALPERN, H. M. LIPINSKI, AND D. R. SNIDER
*University of California, San Diego, La Jolla, California 92037*
65 66.4
(Received 26 July 1968)
p. 2047

Using an off-mass-shell approach, we develop a method for the $O(4)$ expansion of the scattering amplitude for two unequal-mass, arbitrary-spin particles. General-spin spherical harmonics for $O(4)$ are constructed. With the aid of these spherical harmonics, the $M$ amplitude is decomposed into $O(4)$ partial waves. The prescription for obtaining the on-mass-shell helicity states from the $O(4)$ partial waves is given. This $O(4)$ expansion, which is valid even away from $t=0$, is useful in simplifying the Bethe-Salpeter equation.

## $O(4)$ Symmetry, $N\bar{N}$ Scattering, and the Regge Trajectory of the Pion*

H. M. LIPINSKI AND D. R. SNIDER†
*University of California, San Diego, La Jolla, California 92037*
64.7 66.4
(Received 26 July 1968)
p. 2054

The $N\bar{N}$ Bethe-Salpeter equation is studied exploiting the $O(4)$ symmetry of the scattering amplitude at $t=0$. Spinor $O(4)$ spherical harmonics are developed and used in the projection of the Bethe-Salpeter equation both at $t=0$ and for small finite $t$. With the choice of Toller quantum number $M=1$ for the pion trajectory at $t=0$, as seems to be implied by high-energy data, we find that the $M=1$ trajectory must mix with another trajectory near $t=0$ in order to produce a physical pion. In addition, $O(4)$ expansions are given for the $N\bar{N}$ helicity amplitudes for both equal and unequal mass.

## Meson-Baryon and Baryon-Baryon Scattering in Reggeized $U(6)\otimes U(6)$ Theory

R. DELBOURGO* AND HARUN-AR RASHID†
*International Atomic Energy Agency, International Centre for Theoretical Physics, 34001 Trieste, Italy*
64.6 65.5 66.4
(Received 20 June 1968)
p. 2074

A complete set of rules is presented for evaluating the master meson-trajectory exchange contribution to high-energy scattering between mesons ($M$) and baryons ($B$) in $U(6)\otimes U(6)$ theory. The practical implementation of these rules is illustrated in considerable detail for quark-quark scattering as well as for the $35_M$-exchange contribution to $MB$ and $BB$ charge-exchange amplitudes.

## Regge-Pole Eikonal Theory of Small-Angle Pion-Nucleon Scattering*

RICHARD C. ARNOLD AND MAURICE L. BLACKMON
*High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439*
64.6 64.8 65
(Received 25 July 1968)
p. 2082

A quantitative model for high-energy, small-momentum-transfer pion-proton elastic scattering and charge-exchange data (both differential cross sections and polarizations) is presented. The model is based on $P'$ and $\rho$ Regge poles in the optical potential, together with a Pomeranchon whose residue is proportional to the product of electromagnetic form factors of pion and proton. Features not present in the Regge-pole approach, such as the crossover effect and nonzero charge-exchange polarization, appear automatically in this model. Specific properties of our $\rho$ and $P'$ poles are: (a) both choose nonsense; (b) constant reduced residues; (c) linear trajectories; (d) zero helicity flip for $P'$; and (e) helicity-nonflip $P'$ residue given by exchange degeneracy (and symmetry, e.g., from quark model) in terms of $\rho$ residue. The elastic scattering fit is satisfactory for all momenta greater than 6 GeV/$c$ and all squared momentum transfers less than 0.5 GeV$^2$/$c^2$. All available charge-exchange data above 5 GeV/$c$ are fitted well, as are total cross sections and real parts of amplitudes in the forward direction.

## Renormalizable Theory of the Weak Interactions*

N. CHRIST†
*Palmer Physical Laboratory, Princeton University, Princeton, New Jersey 08540*
(Received 13 June 1968)
64.2
p. 2086

A class of renormalizable field theories of the weak interactions is investigated. These theories, of the type first suggested by Kummer and Segrè, postulate that the weak interactions are mediated by the simultaneous exchange of two scalar particles. It is found that although the leptonic and semileptonic weak interactions can be fairly easily described by a two-scalar-exchange mechanism, the structure of observed nonleptonic weak processes presents serious obstacles to the success of such a theory. Nevertheless, two particular models are discussed which may correctly describe not only the leptonic and semileptonic weak interactions but also nonleptonic weak processes.

## Lorentz Poles and Bethe-Salpeter Equations: Does an Infinite Number of Lorentz Poles Exist?

N. P. CHANG AND R. P. SAXENA*
*Physics Department, The City College of the City University of New York, New York, New York 10031*
62.8 64.6
(Received 31 July 1968)
p. 2101

The possibility of the existence of an infinite family of Lorentz poles is investigated using a dynamical model. For spinless scalar particles (mass $m$) scattering via the exchange of another spinless scalar particle (mass $\mu$), the Bethe-Salpeter equation is solved in two limiting cases, $\mu=0$ and $\mu\to\infty$. In both cases it is shown that the $O(4)$ projected amplitude is meromorphic in $n$ (the four-dimensional angular momentum) and that there are an infinite number of poles in the $n$ plane.

## High-Energy Scattering by Nuclei

EDWARD A. REMLER
*College of William and Mary, Williamsburg, Virginia 23185*
51.6 64.9 65
(Received 26 June 1968)
p. 2108

The relationship between the Glauber approximation and Watson's multiple-scattering equation is discussed. On this basis a correction term to the Glauber approximation is proposed.

high-energy scattering between mesons ($M$) and baryons ($B$) in $U(6)\otimes U(6)$ theory. The practical implementation of these rules is illustrated in considerable detail for quark-quark scattering as well as for the $35_W$-exchange contribution to $MB$ and $BB$ charge-exchange amplitudes.

The relationship between the Glauber approximation and Watson's multiple-scattering equation is discussed. On this basis a correction term to the Glauber approximation is proposed.



## Multiperipheral Bootstrap Model*

G. F. Chew and A. Pignotti
*Lawrence Radiation Laboratory, University of California, Berkeley, California 94704*
64.6 64.9 65.5 (Received 3 July 1968) p. 2112

A crude bootstrap model is constructed, based on forward-direction unitarity and the multi-Regge hypothesis. The Pomeranchuk trajectory is generated by iteration of lower-meson trajectories, whose average residue is correlated with average trajectory height. Iteration of the Pomeranchuk turns out to be a small but nonvanishing perturbation that requires the effective average height of the Pomeranchuk trajectory to be slightly less than 1. The model yields a two-parameter formula for multiple-production cross sections that agrees satisfactorily with nucleon-nucleon data up to 30 GeV.

## $K \to 2\pi$ Phenomenology with Small $CP$ Nonconservation

L. David Roper
*Virginia Polytechnic Institute, Blacksburg, Virginia 24061*
64.2 66.2 (Received 18 April 1968; revised manuscript received 8 July 1968) p. 2120

The theoretical expressions for experimentally determined parameters for $K \to 2\pi$ decays are used to determine solutions for various theoretical parameters. This is accomplished by first assuming $CP$ conservation and then treating the $CP$-nonconserving parts of the theoretical expressions as small corrections. We find two types of solutions: one type for which $|\Delta I| = \frac{1}{2}$ dominance is valid, and one type for which $|\Delta I| = \frac{1}{2}$ dominance is not valid. There are two solutions of each type, but only one solution ($|\Delta I| = \frac{1}{2}$ type) yields the original data when substituted in the exact equations. All four solutions are used as input in a least-squares fit to the data, and are thereby transformed into exact solutions. No other exact solutions were found in a large number of random-input searches. Two of the four solutions agree with values of $\mathrm{Re}\,\epsilon$ determined in leptonic decays; however, they give different predictions for the phase of $\eta_{00}$.

## Virtual-Photon–Pion Scattering, Hard-Pion Current Algebra, and Dispersion Relations*

K. C. Gupta
*Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556*
and
J. S. Vaishya
*Theoretical Physics Division, National Physical Laboratory, New Delhi, India*
64.4 66.2 (Received 26 June 1968) p. 2125

It is shown that the $SU(2)\times SU(2)$ current-algebra results for three- and four-point functions are broadly consistent with dispersion relations and the present saturation scheme, provided one writes once-subtracted dispersion relations for some of the form factors occurring in the virtual-photon–pion scattering amplitude.

## Compton Scattering of Spin-One Particles

Wu-Ki Tung*
*Institute of Theoretical Physics, State University of New York, Stony Brook, New York 11790*
64.4 66.2 (Received 17 June 1968) p. 2127

Kinematic singularity- and zero-free invariant amplitudes for Compton scattering of spin-one particles are derived. Gauge invariance is automatically satisfied. A complete set of low-energy theorems is obtained. In addition to the well-known first-order theorems, higher-order theorems also exist. It is shown that up to second order in the photon energy the 12 independent amplitudes are determined by the static moments of the target particle plus four dynamic structure-dependent constants; up to third order they are determined by the static moments plus eight additional constants. Dispersion relations may be written down for the invariant amplitudes without any *ad hoc* subtractions. The asymptotic behavior of these amplitudes is carefully examined, leading to a systematic derivation of possible sum rules and superconvergence relations. Generalizations of previously known sum rules as well as new ones are obtained.

## Low-Energy Compton Scattering by Arbitrary-Spin Targets

Ira J. Kalet*†
*Palmer Physical Laboratory, Princeton University, Princeton, New Jersey‡*
64.4 65 (Received 12 February 1968) p. 2135

The classic low-energy theorem for low-energy Compton scattering by spin-$\frac{1}{2}$ systems derived in 1954 by Low and by Gell-Mann and Goldberger is generalized to include targets of arbitrary spin. Low's method is used in conjunction with a multipole expansion of the electromagnetic current matrix elements. The multipole expansion is given in the Breit frame (total three-momentum = 0) and transformed to the lab system. The result, obtained by replacing the Pauli matrix $\sigma$ in the Low–Gell-Mann–Goldberger result by 2S (where S is the target spin operator), has been derived by Lapidus and Kuang-Chao, but their method of obtaining the current matrix elements is less straightforward than the present one.

## Universal Coupling of the $\omega$ Meson and Regge Residues*

M. K. Banerjee and C. A. Levinson
*University of Maryland, College Park, Maryland 20740*
64.7 64.8 (Received 5 September 1967; revised manuscript received 3 May 1968) p. 2140

In this paper we consider some of the experimental data bearing on the hypothesis of universality of $\omega$ coupling. The low-energy data on the coupling of the $\omega$ meson and the high-energy data on the coupling of the $\omega$-type Regge trajectory have been considered. The data seem to support the universality hypothesis. The universal $\omega$ coupling constant $g_\omega^2/4\pi$ is estimated to be $4.96\pm1.24$, which is higher than the universal $\rho$ coupling constant $g_\rho^2/4\pi = 2.60\pm0.68$, where $g_\rho$ and $g_\omega$ are so normalized that $g_\omega = g_\rho$ in the $SU(6)$ limit. To relate the Regge residues of vector trajectories to the universal coupling constant, we factor out the angular momentum dependence of the former and introduce a "reduced" Regge residue and a scale parameter for each trajectory. The scale parameters for the $\omega$ and the $\rho$ trajectories turn out to be of the order of 290 and 186 MeV, respectively.

## Proposed Test of Toller $\omega$ Dependence of Two-Reggeon–One-Particle Vertex Functions

Richard A. Morrow
*Wilder Laboratory, Dartmouth College, Hanover, New Hampshire 03755*
64.6 64.9 65 (Received 29 July 1968; revised manuscript received 9 September 1968) p. 2147

It is argued that a particular distribution, in the Toller $\omega$ variable, of data from two- to three-particle reactions plausibly described by the double-Regge model, covering a wide range of energies, is *flat* if the two-Reggeon–one-particle vertex function in the amplitude is independent of $\omega$. A prescription for selecting events useful for the test is given, and an estimate of the fraction of events thus selected is made.

## Relation between the Damping of Large Transverse Momenta in Elastic and Inelastic Collisions from Unitarity

D. S. NARAYAN

*Tata Institute of Fundamental Research, Bombay, India*

(Received 5 March 1968; revised manuscript received 6 September 1968)

64.6
65 p. 2154

It is shown from the unitarity relation that the damping of large transverse momenta in inelastic collisions necessarily implies their damping in elastic collisions. In this derivation it is assumed that an inelastic amplitude can be written as a product of a slowly varying factor which depends only on incident energy and the longitudinal components $q_i^L$ of the momenta $q_i$ and another factor which incorporates the exponential damping of transverse momenta.

## Superconvergence Relations and Possible New Resonances in Pion-Baryon Scattering*

D. KIANG, W. C. LIN,† R. SUGANO§

*Dalhousie University, Halifax, Nova Scotia, Canada*

AND

H. E. LIN‡

*St. Mary's University, Halifax, Nova Scotia, Canada*

AND

Y. NOGAMI

*McMaster University, Hamilton, Ontario, Canada*

(Received 8 August 1968)

64.8 p. 2159

Superconvergence relations for the $B^{(+)}$ amplitudes at $t=0$ for pion-baryon scattering are well saturated by low-lying resonances, except for the one for the $\pi$-$\Sigma$ scattering. This remarkable disparity suggests that some new $\pi$-$\Sigma$ resonances may exist. From the unitarity condition on the $p$-wave $\pi$-$\Sigma$ scattering, it is shown that the resonances, if any, are in $(I,J^P)=(0,\frac{3}{2}^+)$ and $(2,\frac{3}{2}^+)$ states.

## Deck-Model Calculation for Doubly Charged $K\pi\pi$ Systems in $KN \to K^*\pi N$ Reactions†

F. BOMSE AND E. J. MOSES

*Department of Physics, Vanderbilt University, Nashville, Tennessee*

64.6
64.7 (Received 3 June 1968)
64.8 p. 2163

A Deck-model calculation for doubly charged $K^*\pi$ systems in $KN \to K^*\pi N$ reactions has been performed. The resulting $K^*\pi$ mass spectra show obvious low-mass enhancements. If the recent remarks of Chew and Pignotti apply to this calculation, these enhancements should be interpreted as evidence for resonance behavior in doubly charged $K^*\pi$ systems.

## Critique of Empirical Mass Formula for Baryons

MOHAMMAD SALEEM

*Department of Physics, University of the Punjab, New Campus, Lahore, Pakistan*

(Received 27 May 1968)

64.8 p. 2166

The significance of the mass formula of French *et al.* is investigated. It is shown that any relation of the type $M=a+M_0n(n+1)$ with different suitable choices of the constants $a$ and $M_0$ will give the masses of the baryons, provided gaps in several of the sequences are allowed, as has been done by French *et al.*

## Erratum

64.4
66.2
70 **Current Algebra and Photoproduction of Pions,** M. S. BHATIA AND P. NARAYANASWAMY [Phys. Rev. **172**, 1742 (1968)]. p. 2167

14
62.6
70 **General Perturbation and Variational Methods for Responses to Time-Dependent Interactions in Quantum Mechanics,** JEAN HEINRICHS [Phys. Rev. **172**, 1315 (1968)]. p. 2167

27
63.4
70 **Ionization Loss at Relativistic Velocities,** C. A. NICOLETTA, P. J. MCNULTY, AND P. L. JAIN [Phys. Rev. **164**, 1693 (1967)]. p. 2167

64.6
65
70 **Solutions of the Bethe-Salpeter and $N/D$ Equations.** K. V. VASAVADA [Phys. Rev. **165**, 1830 (1968)]. p. 2167

Pignotti apply to this calculation, these enhancements should be interpreted as evidence for resonance behavior in doubly charged $K^*\pi$ systems.

tions. K. V. VASAVADA [Phys. Rev. 165, 1856 (1968)].

# Cumulative Analytic Subject Index to Volumes 171–176

References to papers in this cumulative index are arranged in ascending order of volume and page numbers.

## 10 ATOMS, MOLECULES, AND RELATED TOPICS

### 11 ATOMIC STRUCTURE AND SPECTRA (see also 15, 22, and 23)


Self-Broadening of Cesium Resonance Lines at 8521 and 8944 Å—C. L. Chen and A. V. Phelps. 173, 62 (1968)

The Cross Section for the Photodetachment of Electrons from $I^-$—Bruce Steiner. 173, 136 (1968)

Measurement of the Sodium *D*-Line Absolute Oscillator Strengths by the Roschdestvenskii Hook Method—Carl A. Forbrich, Jr., Wayland C. Marlow, and Daniel Bershader. 173, 150 (1968)

Measured Shifts of Cesium Atomic Lines—Correlation with Electron Density Derived from Widths—R. F. Majkowski and R. J. Donohue. 173, 177 (1968)

Improved Stark Profile Calculations for the Hydrogen Lines Hα, Hβ, Hγ, and Hδ—P. Kepple and Hans R. Griem. 173, 317 (1968)

Many-Body Calculation of Atomic Polarizability—Relation to Hartree-Fock Theory—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 16 (1968)

Radiative Lifetimes from Ultraviolet Lines of Ne I, Ne II, and Ne III—James E. Hesser. 174, 68 (1968)

Erratum: Matrix Elements of the Spin-Spin Interaction for the $f^3$ Electron Configuration—Edith F. Reilly. [170, 1 (1968)] 174, 329 (1968)

Regularities in Atomic Oscillator Strengths—W. L. Wiese and A. W. Weiss. 175, 50 (1968)

Mössbauer Effect of $I^{127}$ and $Te^{125}$ in Iodine, Tellurium, and Antimony Compounds—Peter Jung and Werner Triftshäuser. 175, 512 (1968)

Effect of an External Radiation on the Energy Levels of an Electron System—B. L. Jones and M. Verschueren. 176, 42 (1968)

Erratum: Finite Electronic Partition Function from Screened Coulomb Interactions—Carl A. Rouse. [163, 62 (1967)] 176, 423 (1968)


#### 11.2 Atomic Structure Theory


Exchange Potential for Electrons in Atoms and Solids—David A. Liberman. 171, 1 (1968)

Configuration Interaction Integrals for Pu I and II—M. Wilson. 171, 4 (1968)

Use of the Hartree-Fock Approximation in Computing Electron Affinities—Arthur M. Lesk. 171, 7 (1968)

Measurement of the Electric Dipole Polarizabilities of Metastable Mercury—Judah Levine, Robert J. Celotta, and Benjamin Bederson. 171, 31 (1968)

Padé-Approximant Calculation of the Nonretarded van der Waals Coefficients for Two and Three Helium Atoms—K. T. Tang and M. Karplus. 171, 70 (1968)

Concerning the Stability of the Negative Ions $H^-$ and $Li^-$—William A. Goddard. III. 172, 7 (1968)

Matrix Elements Between Configurations Having Several Open Shells. I—Lloyd Armstrong Jr. 172, 12 (1968)

Matrix Elements Between Configurations Having Several Open Shells. II—Lloyd Armstrong Jr. 172, 18 (1968)

Fully Coupled Hartree-Fock Calculations of the Refractive Index. Dynamic Polarizability and Verdet Coefficients of Helium, Beryllium, and Neon—V. G. Kaveeshwar, Kwong T. Chung, and R. P. Hurst. 172, 35 (1968)

Calculation of the Magnetic Moment of Atomic Fluorine—V. Beltrán-López, E. Ley Koo, N. Segovia, and E. Blaisten. 172, 44 (1968)

Correlation Coefficients for Electronic Wave Functions—Werner Kutzelnigg, Giuseppe Del Re, and Gaston Berthier. 172, 49 (1968)

Angular Symmetry of the 2-Matrix—Claude Garrod. 172, 173 (1968)

Many-Body Approach to Electron Correlation in Atoms and Molecules—Karl F. Freed. 173, 1 (1968)

Generalized Perturbation Theory and its Application to the Problem of the Description of Electron Correlation in Atoms and Molecules—Karl F. Freed. 173, 24 (1968)

Atomic Term Patterns—B. R. Judd. 173, 39 (1968)

Atomic *g* Electrons—B. R. Judd. 173, 40 (1968)

Magnetic Interactions in Mixed Configurations—Lloyd Armstrong, Jr. and S. Feneuille. 173, 58 (1968)

Antisymmetrization of Geminal Wave Functions. III. Calculations of the Density Matrix and Energy of a Three-Electron Atom—F. David Peat. 173, 69 (1968)

Magnetic Hyperfine Structure of Lithium, Using an Approximate Projected Hartree-Fock Method—Sten Lunell. 173, 85 (1968)

Perturbation-Theoretic Approach to Atoms and Molecules—Jeremy I. Musher and Jerome M. Schulman. 173, 93 (1968)

Hyperfine Contact Interactions in Oxygen Calculated by Many-Body Theory—Hugh P. Kelly. 173, 142 (1968)

Erratum: A New Type of Wave Function for Li, $Be^+$, and $B^{++}$—William A. Goddard, III. [169, 120 (1968)] 173, 325 (1968)

Many-Body Approach to the Atomic Hyperfine Problem. I. Lithium-Atom Ground State—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 1 (1968)

Magnetic Parameters for the Configuration $f^3$—Hannah Crosswhite, H. M. Crosswhite, and B. R. Judd. 174, 89 (1968)

Accurate Atomic and Molecular Wave Functions Without Exchange—Jeremy I. Musher and Robert Silbey. 174, 94 (1968)

Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions—Thomas C. Tucker, Louis D. Roberts, C. W. Nestor, Jr., Thomas A. Carlson, and F. B. Malik. 174, 118 (1968)

Erratum: Semiempirical Electron Correlation in the Carbon Atom—Raymond W. Mires. [155, 1 (1967)] 174, 329 (1968)

New Foundation for the Use of Pseudopotentials in Metals—William A. Goddard, III. 174, 659 (1968)

Electromagnetic Interactions of Loosely-Bound Composite Systems—Stanley J. Brodsky and Joel R. Primack. 174, 2071 (1968)

Atomic Bethe-Goldstone Equations. III. Correlation Energies of Ground States of Be, B, C, N, O, F, and Ne—R. K. Nesbet. 175, 2 (1968)

Radiative Lifetimes in the Resonance Series of Ar I—George M. Lawrence. 175, 40 (1968)

Theoretical Analysis of the Hyperfine Structure of Alkali Atoms—L. Tterlikkis, S. D. Mahanti, and T. P. Das. 176, 10 (1968)

Spin-Extended Wave Functions for First-Row Atoms—Uzi Kaldor. 176, 19 (1968)

Atomic Hyperfine Structure. I. Polarization Wave Functions for the Ground States of B, C, N, O, and F.—Henry F. Schaefer III, Richard A. Klemm, and Frank E. Harris. 176, 49 (1968)

*Ab Initio* Calculation of Screening Effects on $|\psi(0)|^2$ for Heavy Atoms—M. Wilson. 176, 58 (1968)

Calculation of the $^1S$ State of the Beryllium Atom in Hylleraas Coordinates—R. F. Gentner and E. A. Burke. 176, 63 (1968)

Spin-Extended Wave Function for Atomic Sodium—Uzi Kaldor 176, 71 (1968)

Properties of the Lithium Sequence—A. Dalgarno and E. M. Parkinson. 176, 73 (1968)

Doubly Excited States of $H^-$ of High Principal Quantum Number: Implications for Electron-Atom Ionization—A. Temkin, A. K. Bhatia, and E. Sullivan. 176, 80 (1968)

High-Order Perturbation Theory for a One-Electron Ion in a Uniform Electric Field—Lawrence B. Mendelsohn. 176, 90 (1968)

Magnetic Hyperfine Structure and Core Polarization in the Excited States of Lithium—William A. Goddard, III. 176, 106 (1968)

Relativistic Calculations of Electron Binding Energies by a Modified Hartree-Fock-Slater Method—Arne Rosén and Ingvar Lindgren. 176, 114 (1968)

Nonadiabatic Long-Range Forces—A. Dalgarno, G. W. F. Drake, and G. A. Victor. 176, 194 (1968)

Shell Structure and the Thomas-Fermi Equation of State—J. W. Zink. 176, 279 (1968)

Multiphoton Ionization of Atomic Hydrogen—Wolfgang Zernik. 176, 420 (1968)

Erratum: Coupled-State Calculations of Proton-Hydrogen Scattering in the Sturmian Representation—D. F. Gallaher and L. Wilets. [169, 139 (1968)] 176, 423 (1968)

Erratum: Screened Coulomb Solutions of the Schrödinger Equation—Carl A. Rouse. [159, 41 (1967)] 176, 423 (1968)

## 11.4 Fine and Hyperfine Spectra (see also 5(2-5).1)

Measurements of $g_J$ Ratios for $Rb^{85}$, $Rb^{87}$, Hydrogen, and Deuterium, and of the Hyperfine Separation of Deuterium—G. S. Hayne, E. S. Ensberg, and H. G. Robinson. 171, 20 (1968)

Remeasurement of the Lamb Shift in D, $n=2$—B. L. Cosens. 173, 49 (1968)

Hyperfine Structure and Lifetimes of the $4^2P_{3/2}$ and $5^2P_{3/2}$ States of $K^{39}$—Robert W. Schmieder, Allen Lurio, and W. Happer. 173, 76 (1968)

Magnetic Hyperfine Structure of Lithium, Using an Approximate Projected Hartree-Fock Method—Sten Lunell. 173, 85 (1968)

Magnetic Hyperfine Interaction Constants and Electronic $g$ Factors for Eight Atomic States of $Rh^{103}$—Y. W. Chan, W. J. Childs, and L. S. Goodman. 173, 107 (1968)

Hyperfine Contact Interactions in Oxygen Calculated by Many-Body Theory—Hugh P. Kelly. 173, 142 (1968)

Determination of $g$-Factor Ratios for Free $Rb^{85}$ and $Rb^{87}$ Atoms—C. W. White, W. M. Hughes, G. S. Hayne, and H. G Robinson. 174, 23 (1968)

Pressure Shifts of Hyperfine Splitting of Hydrogen and Tritium in Argon—R. A. Brown and F. M. Pipkin. 174, 48 (1968)

Hyperfine Pressure Shift and van der Waals Interaction. I. Hydrogen-Helium System—Supriya Ray, J. D. Lyons, and T. P. Das. 174, 104 (1968)

Hyperfine Pressure Shift and van der Waals Interaction. II. Nitrogen-Helium System—J. D. Lyons, Supriya Ray, and T. P. Das. 174, 112 (1968)

Electric Dipole Moments of Alkali Atoms. A Limit to the Electric Dipole Moment of the Free Electron—J. P. Carrico, E. Lipworth, P. G. H. Sandars, T. S. Stein, and M. C. Weisskopf. 174, 125 (1968)

$O(4)$ Symmetry of the Hydrogen Atom and the Lamb Shift—Michael Lieber. 174, 2037 (1968)

Rare-Gas-Induced $g_J$ Shifts in the Ground States of Alkali Atoms—Roger M. Herman. 175, 10 (1968)

Hyperfine Structure of the $2^3P$ Level in $He^3$—Lars Hambro. 175, 31 (1968)

Gyromagnetic Ratio of Helium $2^3S_1$ Atoms by Optical Pumping: Level Shifts—L. D. Schearer and F. D. Sinclair. 175, 36 (1968)

Spins and Nuclear Moments of $Sb^{115}$, $Sb^{117}$, $Sb^{118}$, $Sb^{119}$, and $Sb^{120}$—A. D. Jackson, Jr., E. H. Rogers, Jr., and G. J. Garrett. 175, 65 (1968)

Hyperfine Structure of $^{67}Ga$ and $^{72}Ga$—Vernon J. Ehlers, Yurdanur Kabasakal, Howard A. Shugart, and Orhan Tezer. 176, 25 (1968)

Atomic Hyperfine Structure. I. Polarization Wave Functions for the Ground States of B, C, N, O, and F.—Henry F. Schaefer III, Richard A. Klemm, and Frank E. Harris. 176, 49 (1968)

Magnetic Hyperfine Structure and Core Polarization in the Excited States of Lithium—William A. Goddard, III. 176, 106 (1968)

Erratum: Precise Theory of the Zeeman Spectrum for Atomic Hydrogen and Deuterium and the Lamb Shift—Stanley J. Brodsky and Ronald G. Parsons. [163, 134 (1967)] 176, 423 (1968)

## 11.6 X Rays (see also 42.1)

X-Ray Determination of Electron Momenta in Li, Be, B, Na, Mg, Al, and LiF—Walter C. Phillips and R. J. Weiss. 171, 790 (1968)

$L$-Series Emission Spectrum of Germanium—Richard D. Deslattes. 172, 625 (1968)

Relativistic Study of $KL_1L_1$ Auger Transition Probabilities—Dipankar Chattarji and Benoy Talukdar. 174, 44 (1968)

Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions—Thomas C. Tucker, Louis D. Roberts, C. W. Nestor, Jr., Thomas A. Carlson, and F. B. Malik. 174, 118 (1968)

Experimental Evidence for the Parratt X-Ray Excitation Theory—Staffan Bergwall and Arun S. Nigavekar. 175, 33 (1968)

Measurements of $L_2$- and $L_3$-Subshell Fluorescence Yields in Heavy Elements—Richard E. Price, Hans Mark, and C. D. Swift. 176, 3 (1968)

## 12 MOLECULAR STRUCTURE AND SPECTRA (see also 15)

Hyperfine Structure in the Millimeter Spectrum of Hydrogen Sulfide: Electric Resonance Spectroscopy on Asymmetric-Top Molecules—R. E. Cupp, R. A. Kempf, and J. J. Gallagher. 171, 60 (1968)

Zeeman Splitting of Vibronic Levels for Octahedral Actinide and Lanthanide Complexes, Free and in Crystals—R. A. Satten, D. R. Johnston, and E. Y. Wong. 171, 370 (1968)

Photodissociation of $H_2^+$ and $D_2^+$: Theory—Gordon H. Dunn. 172, 1 (1968)

Evidence for the $^3\Delta_u$–$B^3\Pi_g$ Transition in $N_2$—H. L. Wu and W. Benesch. 172, 31 (1968)

Hyperfine Structure of $N^{15}H_3$—Stephen G. Kukolich. 172, 59 (1968)

Nuclear Radio-Frequency Spectra of a Series of Tetrahedral Molecules—Irving Ozier, Lawrence M. Crapo, and Sang Soo Lee. 172, 63 (1968)

Many-Body Approach to Electron Correlation in Atoms and Molecules—Karl F. Freed. 173, 1 (1968)

Generalized Perturbation Theory and its Application to the Problem of the Description of Electron Correlation in Atoms and Molecules—Karl F. Freed. 173, 24 (1968)

Photo-Ionization of the Hydrogen Molecule—S. P. Khare. 173, 43 (1968)

Resonance Scattering of Slow Electrons from $H_2$ and CO Angular Distributions—H. Ehrhardt, L. Langhans, F. Linder and H. S. Taylor. 173, 222 (1968)

Erratum: Recombination of Electrons and Molecular Helium Ions—Gunthard K. Born. [169, 155 (1968)] 173, 325 (1968)

Application of Geminal Methods to Molecular Calculations—C. F. Bender, E. R. Davidson, and F. D. Peat. 174, 75 (1968)

Ground-State Energy Eigenvalues and Eigenfunctions for an Electron in an Electric-Dipole Field—J. E. Turner, V. E. Anderson, and Kenneth Fox. 174, 81 (1968)

Accurate Atomic and Molecular Wave Functions Without Exchange—Jeremy I. Musher and Robert Silbey. 174, 94 (1968)

Measurements of the Electron Impact Excitation Cross Section of $N_2^+$ First Negative Bands—B. N. Srivastava and I. M. Mirza. 176, 137 (1968)

Rotational Excitation of Polar Molecules by Electrons—M. H. Mittleman and J. L. Peacher and B. F. Rozsnyai. 176, 180 (1968)

Theory of Polarization of Molecular Line Radiation Excited by Electron Impact—A. Norman Jette and Patrick Cahill. 176, 186 (1968)

Erratum: Evidence for the $^3\Delta_u$–$B^3\Pi_g$ Transition in $N_2$—H. L. Wu and W. Benesch. [172, 31 (1968)] 176, 423 (1968)

### 12.5 Chemical Physics

Optical Third-Harmonic Generation in Dye Solutions—R. K. Chang and Lee K. Galbraith. 171, 993 (1968)

Equilibrium Constant and Rates for the Reversible Reaction $N_4^+ = N_2^+ + N_2$—R. N. Varney. 174, 165 (1968)

Rotational Excitation in Ion-Molecule Collisions: The System $H_2^+ + N_2$—John H. Moore, Jr. and John P. Doering. 174, 178 (1968)

Possible Cooperative Phase for Electrons in Double-Stranded DNA—E. W. Fenton. 174, 517 (1968)

Configuration Interaction Theory. Effects of Overlapping Resonances—Frederick H. Mies. 175, 164 (1968)

Angular Dependence of Scattering Products in Electron-Molecule Resonant Excitation and in Dissociative Attachment—Thomas F. O'Malley and Howard S. Taylor. 176, 207 (1968)

## 13 ATOMIC AND MOLECULAR COLLISIONS

Padé-Approximant Calculation of the Nonretarded van der Waals Coefficients for Two and Three Helium Atoms—K. T. Tang and M. Karplus. 171, 70 (1968)

Perturbation Theory for Exchange Interactions between Atoms and Molecules. I—A. B. Ritchie. 171, 125 (1968)

Rotational Correlation Functions in Neutron Scattering by Molecular Gases—Ashok K. Agrawal and Sidney Yip. 171, 263 (1968)

Rubidium and Cesium Excitation Transfer in Nearly Adiabatic Collisions with Inert Gases—Alan Gallagher. 172, 88 (1968)

Estimation of the Cross Sections for Collision Transfer of Excitation in Helium—F. T. Chan. 172, 96 (1968)

Adiabatic Approximation and Necessary Conditions for the Existence of Bound States—F. H. Gertler, H. B. Snodgrass, and Larry Spruch. 172, 110 (1968)

Measurement of Volume Recombination Coefficients in Highly Ionized Alkali Plasmas—S. von Goeler, R. W. Motley, and R. Ellis. 172, 162 (1968)

Erratum: Quantum Theory of Collision-Induced Absorption in Rare-Gas Mixtures—Howard B. Levine. [160, 159 (1967)] 172, 241 (1968)

Self-Broadening of Cesium Resonance Lines at 8521 and 8944 Å—C. L. Chen and A. V. Phelps. 173, 62 (1968)

Calculation of Resonance Broadening—Haider R. Zaidi. 173, 123 (1968)

Total Cross Sections for Inelastic Scattering of Charged Particles by Atoms and Molecules. II. Negative Hydrogen Ion—Mitio Inokuti and Yong-Ki Kim. 173, 154 (1968)

Short-Range Effects on the Pressure Shift for a Nitrogen Atom in a Rare-Gas Atmosphere—Supriya Ray and T. P. Das. 174, 32 (1968)

Hyperfine Pressure Shift and van der Waals Interaction. I. Hydrogen-Helium System—Supriya Ray, J. D. Lyons, and T. P. Das. 174, 104 (1968)

Hyperfine Pressure Shift and van der Waals Interaction. II. Nitrogen-Helium System—J. D. Lyons, Supriya Ray, and T. P. Das. 174, 112 (1968)

Electronic Transitions in Slow Collisions of Atoms and Molecules. I—Joseph C. Y. Chen and Kenneth M. Watson. 174, 152 (1968)

Diffusion of He($2^3S_1$) in Helium Gas; $2\,^3S_1 - 1\,^1S_0$ Interaction Potentials at Long Range—W. A. Fitzsimmons, N. F. Lane, and G. K. Walters. 174, 193 (1968)

Low-Energy Method in High-Energy Scatterings—Yukap Hahn. 174, 1135 (1968)

Rare-Gas-Induced $g_J$ Shifts in the Ground States of Alkali Atoms—Roger M. Herman. 175, 10 (1968)

Metastable Atoms and Molecules. III. Metastable Impacts on Surfaces with Various Work Functions—R. N. Varney. 175, 98 (1968)

Theory of Electronic Transitions in Slow Atomic Collisions—Jean Heinrichs. 176, 141 (1968)

Nonadiabatic Long-Range Forces—A. Dalgarno, G. W. F. Drake, and G. A. Victor. 176, 194 (1968)

Electron-Temperature Dependence of Electron-Ion Recombination in Argon—F. J. Mehr and Manfred A. Biondi. 176, 322 (1968)

### 13.2 With Incident Ions

Lyman-$\alpha$ Production and Polarization in $He^+$ Collisions with H and $H_2$—Robin A. Young, R. F. Stebbings, and J. William McGowan. 171, 85 (1968)

Mobilities of Mass-Identified $H_3^+$ and $H^+$ Ions in Hydrogen—D. L. Albritton, T. M. Miller, D. W. Martin, and E. W. McDaniel. 171, 94 (1968)

Low-Energy (1- to 100-eV) Charge-Transfer Cross-Section Measurements for Noble-Gas-Ion Collisions with Gases—P. Mahadevan and G. D. Magnuson. 171, 103 (1968)

Measurement of High-Energy Charge-Transfer Cross Sections for Incident Protons and Atomic Hydrogen in Various Gases—L. H. Toburen, M. Y. Nakai, and R. A. Langley. 171, 114 (1968)

Erratum: Study of $H_2^+ + H_2 \rightarrow H_3^+ + H$ Using Merging Beams—R. H. Neynaber and S. M. Trujillo. [167, 63 (1968)] 171, 282 (1968)

Role of Electronic Structure in Determining the Charges of Fast Ions in Matter—R. L. Wolke. 171, 301 (1968)

Vibrational Excitation Effects on Charge-Transfer Processes Involving $H_2^+$ and $D_2^+$ Between 70 and 1000 eV—Howard C. Hayden and Robert C. Amme. 172, 104 (1968)

Reactions of $H^+$ in $H_2$ and $D^+$ in $D_2$: Mobilities of Hydrogen and Alkali Ions in $H_2$ and $D_2$ Gases—T. M. Miller, J. T. Moseley, D. W. Martin, and E. W. McDaniel. 173, 115 (1968)

Electron Capture into the $n=3$ States of H by Fast $H^+$ Impact on $N_2$—R. H. Hughes, B. M. Doughty, and A. R. Filippelli. 173, 172 (1968)

Stopping Powers and Ranges of 5–90-MeV $S^{32}$, $Cl^{35}$, $Br^{79}$, and $I^{127}$ Ions in $H_2$, He, $N_2$, Ar, and Kr: A Semiempirical Stopping Power Theory for Heavy Ions in Gases and Solids—T. E. Pierce and Marshall Blann. 173, 390 (1968)

Excitation of the $n^1S$ States of Helium by Proton Impact—William J. B. Oldham, Jr. 174, 145 (1968)

Measurement of One- and Two-Electron-Loss Cross Sections for $He^-$ Ions in $H_2$, He, and Ne Gases (400–1500 keV)—G. Ryding, A. B. Wittkower, and P. H. Rose. 174, 149 (1968)

Equilibrium Constant and Rates for the Reversible Reaction $N_4^+ = N_2^+ + N_2$—R. N. Varney. 174, 165 (1968)

Alpha-Particle Ionization in Argon-Methane Mixtures and the Energy Dependence of the Ion Pair-Formation Energy—William P. Jesse. 174, 173 (1968)

Rotational Excitation in Ion-Molecule Collisions: The System $H_3^+ + N_2$—John H. Moore, Jr. and John P. Doering. 174, 178 (1968)

Charge-Exchange Collisions Between Helium Ions and Cesium Vapor in the Energy Range 1.5–25 keV—A. S. Schlachter, D. H. Loyd, P. J. Bjorkholm, L. W. Anderson, and W. Haeberli. 174, 201 (1968)

Coincidence Measurements of Krypton-Krypton Collisions—M. P. McCaughey, E. J. Knystautas, and E. Everhart. 175, 14 (1968)

Polarization of Light from Collisions of a Proton Beam with Helium Atoms—Daniel Krause, Jr., and Edward A. Soltysik 175, 142 (1968)

Generalized Oscillator Strengths of the Helium Atom. I—Yong-Ki Kim and Mitio Inokuti. 175, 176 (1968)

Theory of High-Energy Ion-Atom Collisions with Electron Exchanges—Yukap Hahn. 175, 197 (1968)

Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10–180 MeV—C. D. Moak, H. O. Lutz, L. B. Bridwell, L. C. Northcliffe, and S. Datz. 176, 427 (1968)

## 13.4 With Incident Electrons

Optical-Potential Calculation of Electron-Hydrogen Singlet Scattering—Hugh P. Kelly. 171, 54 (1968)

Inelastic Scattering Cross Sections for 200- and 400-keV Electrons—C. E. Dick and J. W. Motz. 171, 75 (1968)

Spin Exchange between Optically Oriented Metastable Helium Atoms and Thermal Electrons in a Flowing Afterglow—L. D. Schearer. 171, 81 (1968)

Electron-Hydrogen Scattering Calculation—Robert L. Armstead. 171, 91 (1968)

Possible Resonance in Positron-Hydrogen Scattering—Richard J. Drachman. 171, 110 (1968)

Angular Dependence of $2^3S$ Excitation of He by High-Energy Electron Impact—Ik-Ju Kang and Chan Kyoo Choi. 171, 123 (1968)

Calculation of Some Three-Body Scattering Amplitudes—L. Schlessinger. 171, 1523 (1968)

Dissociative Electron Attachment in $I_2$ Vapor at 295°K—Frank K. Truby. 172, 24 (1968)

Polarization in Low-Energy Electron Scattering: Carbon and Nitrogen—Ronald J. W. Henry. 172, 99 (1968)

Resonance Scattering and the Drift Motion of Electrons Through Gases—Lothar Frommhold. 172, 118 (1968)

Dissociative Attachment in CO and NO—P. J. Chantry. 172, 125 (1968)

Measurements of the Stark Broadening of Two Neutral Helium Lines in a Plasma—J. R. Greig, C. P. Lim, G. A. Moo-Young, G. Palumbo, and Hans R. Griem. 172, 148 (1968)

Electron Broadening of Isolated Spectral Lines—Haider R. Zaidi. 173, 132 (1968)

Critical Assessment of the Polarized-Orbital Method in Atomic Scattering—Marvin H. Mittleman and Jerry L. Peacher. 173, 160 (1968)

Coupled-States Method for Scattering Calculations—J. F. Perkins. 173, 164 (1968)

Polarization Potential in Low-Energy Electron-$H_2$ Scattering—Neal F. Lane and Ronald J. W. Henry. 173, 183 (1968)

Variational Bounds in Positron-Atom Scattering—Richard J. Drachman. 173, 190 (1968)

Faddeev Equations for Atomic Problems and Solutions for the ($e$, H) System—James S. Ball, Joseph C. Y. Chen, and David Y. Wong. 173, 202 (1968)

Upper and Lower Bounds on $s$-Wave Electron-Hydrogen Scattering. I—Rabinder N. Madan. 173, 214 (1968)

Resonance Scattering of Slow Electrons from $H_2$ and CO Angular Distributions—H. Ehrhardt, L. Langhans, F. Linder, and H. S. Taylor. 173, 222 (1968)

Erratum: Calculation of Low-Energy Electron-Atom Transport Cross Sections from Total Cross-Section Measurements—R. L. Fox. [168, 1 (1968)] 173, 325 (1968)

Erratum: Recombination of Electrons and Molecular Helium Ions—Gunthard K. Born. [169, 155 (1968)] 173, 325 (1968)

Ground-State Energy Eigenvalues and Eigenfunctions for an Electron in an Electric-Dipole Field—J. E. Turner, V. E. Anderson, and Kenneth Fox. 174, 81 (1968)

Formal Problems in the Theory of Dissociative Attachment and Recombination—Joseph C. Y. Chen and Marvin H. Mittleman. 174, 185 (1968)

Elastic Scattering of Low-Energy Electrons from Metastable Helium—Ralph C. Sklarew and Joseph Callaway. 175, 103 (1968)

Rearrangement Collisions: Effect of Core Terms, Nonorthogonality, and Conservation of Particle Flux on Approximate Theories—Donald G. Truhlar, David C. Cartwright, and Aron Kuppermann. 175, 113 (1968)

Analysis of the Harris Variational Method in Scattering Theory—R. K. Nesbet. 175, 134 (1968)

Angular Distribution of the Outgoing Electrons in Electronic Ionization—A. E. Glassgold and G. Ialongo. 175, 151 (1968)

Configuration Interaction Theory. Effects of Overlapping Resonances—Frederick H. Mies. 175, 164 (1968)

Generalized Oscillator Strengths of the Helium Atom. I—Yong-Ki Kim and Mitio Inokuti. 175, 176 (1968)

Elastic Scattering of Slow Electrons by Two-Electron Ions—M. R. C. McDowell. 175, 189 (1968)

Doubly Excited States of $H^-$ of High Principal Quantum Number: Implications for Electron-Atom Ionization—A. Temkin, A. K. Bhatia, and E. Sullivan. 176, 80 (1968)

Measurements of the Electron Impact Excitation Cross Section of $N_2^+$ First Negative Bands—B. N. Srivastava and I. M. Mirza. 176, 137 (1968)

Contribution of Perturber Radiation to the Shapes of Spectral Lines Broadened by Electron Impacts—D. D. Burgess. 176, 150 (1968)

Formation of Ionized Excited States Through the Loss of the Metastable Electron in Noble-Gas Atoms—S. H. Koozekanani. 176, 160 (1968)

Electron-Impact Ionization of H (2s) and H (2p)—H. Lee Kyle and K. Omidvar. 176, 164 (1968)

Spin Polarization of Low-Energy Electrons Scattered Elastically from Atoms and Molecules—A. C. Yates. 176, 173 (1968)

Rotational Excitation of Polar Molecules by Electrons—M. H. Mittleman and J. L. Peacher and B. F. Rozsnyai. 176, 180 (1968)

Theory of Polarization of Molecular Line Radiation Excited by Electron Impact—A. Norman Jette and Patrick Cahill. 176, 186 (1968)

Angular Dependence of Scattering Products in Electron-Molecule Resonant Excitation and in Dissociative Attachment—Thomas F. O'Malley and Howard S. Taylor. 176, 207 (1968)

## 14 RADIATIVE PROCESSES; POLARIZATION AND RESONANCE; BREMSSTRAHLUNG (see also 21)

Light Shifts in the Alkali Atoms—B. S. Mathur, H. Tang, and W. Happer. 171, 11 (1968)

Parametrization of Absorption-Line Profiles—Bruce W. Shore. 171, 43 (1968)

Photon Echo in Gaseous Media—M. Scully, M. J. Stephen, and David C. Burnham. 171, 213 (1968)

Incoherent-Scattering Function, Total Pair-Production Cross Section, and Pair-Production Length for Helium—T. M. Knasel. 171, 1643 (1968)

Photodissociation of $H_2^+$ and $D_2^+$: Theory—Gordon H. Dunn. 172, 1 (1968)

Multiphoton Ionization of Atomic Hydrogen in the Ground State—Y. Gontier and M. Trahin. 172, 83 (1968)

Measurement of Volume Recombination Coefficients in Highly Ionized Alkali Plasmas—S. von Goeler, R. W. Motley, and R. Ellis. 172, 162 (1968)

Erratum: Quantum Theory of Collision-Induced Absorption in Rare-Gas Mixtures—Howard B. Levine. [160, 159 (1967)] 172, 241 (1968)

Boundary Conditions in Maxwell's Theory—Shuang-Yuan Shieh. 172, 1310 (1968)

General Perturbation and Variational Methods for Responses to Time-Dependent Interactions in Quantum Mechanics—Jean Heinrichs. 172, 1315 (1968)

Lifetimes and Alignment Depolarization Cross Sections of the $(3p^5\ 4p)\ ^3D_3$ and $^1D_2'$ Levels in Argon and the $(1s\,2p)\ ^3P$ Term in Helium—Donald A. Landman. 173, 33 (1968)

Photo-Ionization of the Hydrogen Molecule—S. P. Khare. 173, 43 (1968)

Photoelectron Spectroscopy of the Rare Gases—James A. R. Samson and R. B. Cairns. 173, 80 (1968)

Calculation of Resonance Broadening—Haider R. Zaidi. 173, 123 (1968)

Electron Broadening of Isolated Spectral Lines—Haider R. Zaidi. 173, 132 (1968)

The Cross Section for the Photodetachment of Electrons from $I^-$—Bruce Steiner. 173, 136 (1968)

Measurement of the Sodium *D*-Line Absolute Oscillator Strengths by the Roschdestvenskii Hook Method—Carl A. Forbrich, Jr., Wayland C. Marlow, and Daniel Bershader. 173, 150 (1968)

Many-Body Calculation of Atomic Polarizability—Relation to Hartree-Fock Theory—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 16 (1968)

Short-Range Effects on the Pressure Shift for a Nitrogen Atom in a Rare-Gas Atmosphere—Supriya Ray and T. P. Das. 174, 32 (1968)

Quantum Theory of the Smith-Purcell Experiment—Solomon J. Glass and H. Mendlowitz. 174, 57 (1968)

Radiative Lifetimes from Ultraviolet Lines of Ne I, Ne II; and Ne III—James E. Hesser. 174, 68 (1968)

Electric Dipole Moments of Alkali Atoms. A Limit to the Electric Dipole Moment of the Free Electron—J. P. Carrico, E. Lipworth, P. G. H. Sandars, T. S. Stein, and M. C. Weisskopf. 174, 125 (1968)

Rotational Excitation in Ion-Molecule Collisions: The System $H_2^+ + N_2$—John H. Moore, Jr. and John P. Doering. 174, 178 (1968)

Anti-Stokes Generation in Trapped Filaments of Light—C. A. Sacchi, C. H. Townes, and J. R. Lifsitz. 174, 439 (1968)

Polarization Effects in Induced Emission of Bremsstrahlung—Hans Kolbenstvedt and Haakon A. Olsen. 175, 11 (1968)

Photo-Ionization Cross Sections of the Elements Helium to Xenon—Eugene J. McGuire. 175, 20 (1968)

Gyromagnetic Ratio of Helium $2^3S_1$ Atoms by Optical Pumping: Level Shifts—L. D. Schearer and F. D. Sinclair. 175, 36 (1968)

Radiative Lifetimes in the Resonance Series of Ar I—George M. Lawrence. 175, 40 (1968)

Radiative Mean-Life Measurements of Some Atomic-Hydrogen Excited States Using Beam-Foil Excitation—E. L. Chupp, L. W. Dotchin, and D. J. Pegg. 175, 44 (1968)

Regularities in Atomic Oscillator Strengths—W. L. Wiese and A. W. Weiss. 175, 50 (1968)

Polarization of Light from Collisions of a Proton Beam with Helium Atoms—Daniel Krause, Jr., and Edward A. Soltysik. 175, 142 (1968)

Calculation of the Dependence of Emitted Light on Charge Density for Two-Electron Collisional-Radiative Recombination in the Hydrogenic Approximation—C. B. Collins. 175, 160 (1968)

Configuration Interaction Theory. Effects of Overlapping Resonances—Frederick H. Mies. 175, 164 (1968)

Measurements of Photon Correlations in Partially Coherent Light—D. B. Scarl. 175, 1661 (1968)

Properties of the Lithium Sequence—A. Dalgarno and E. M. Parkinson. 176, 73 (1968)

Angular Distribution of Molecular Photoelectrons—John C. Tully, R. Stephen Berry and Bryan J. Dalton. 176, 95 (1968)

Photo-Ionization of Lithium: A Many-Body Calculation—Edward S. Chang and M. R. C. McDowell. 176, 126 (1968)

Contribution of Perturber Radiation to the Shapes of Spectral Lines Broadened by Electron Impacts—D. D. Burgess. 176, 150 (1968)

Theory of Polarization of Molecular Line Radiation Excited by Electron Impact—A. Norman Jette and Patrick Cahill. 176, 186 (1968)

Linear Stark Broadening in High-Density Lithium Plasma—B. Ya'akobi. 176, 227 (1968)

Multiphoton Ionization of Atomic Hydrogen—Wolfgang Zernik. 176, 420 (1968)

Photon Scattering from Bound Atomic Systems at Very High Energy—M. L. Goldberger and F. E. Low. 176, 1778 (1968)

Erratum: General Perturbation and Variational Methods for Responses to Time-Dependent Interactions in Quantum Mechanics—Jean Heinrichs. [172, 1315 (1968)] 176, 2167 (1968)

### 15 POSITRONIUM, MUONIUM, AND MESONIC ATOMS AND MOLECULES (see also 25)

Binding Energy of the Positronium Molecule—R. R. Sharma. 171, 36 (1968)

Possible Resonance in Positron-Hydrogen Scattering—Richard J. Drachman. 171, 110 (1968)

$2P\Pi$ States of Muonic Molecules—Benjamin P. Carter. 173, 55 (1968)

Variational Bounds in Positron-Atom Scattering—Richard J. Drachman. 173, 190 (1968)

Precise Muonic Kα Isotope Shifts for Nuclides from Si to Sn—R. D. Ehrlich. 173, 1088 (1968)

Pressure Shifts of Hyperfine Splitting of Hydrogen and Tritium in Argon—R. A. Brown and F. M. Pipkin. 174, 48 (1968)

Hyperfine Structure of the $(p\mu p)^+$, $L=1$, Ortho, Bound State—Alvin M. Halpern. 174, 62 (1968)

Meson Captures in Solids—M. Y. Au-Yang and Marvin L. Cohen. 174, 468 (1968)

## 20 ATOMS, NUCLEI, AND PARTICLES IN MATTER

### 21 MAGNETIC RESONANCE (see also 14, 4(6-9).6, and 49.7)

Quadrupolar Hyperfine Anisotropy in $Fe(NH_4SO)_2\ 6H_2O$ and Its Comparison with the Magnetic Susceptibility—R. Ingalls, K. Ōno, and Louis Chandler. 172, 295 (1968)

Stochastic Theory of Line Shape: Generalization of the Kubo-Anderson Model—M. Blume. 174, 351 (1968)

Nuclear-Quadrupole-Resonance Study of Lattice Dynamics in $K_2PtCl_6$—K. R. Jeffrey and R. L. Armstrong. 174, 359 (1968)

Spin-Lattice Relaxation in Pure and Europium-Doped $BaF_2$ Crystals at High and Low Temperatures—J. R. Miller and P. P. Mahendroo. 174, 369 (1968)

Nuclear and Electron Resonance Study of the Paramagnetic Cobalt Ion—Sung Ho Choh and G. S. Seidel. 174, 385 (1968)

Magnetic Field Dependence of the Ruderman-Kittel-Kasuya-Yosida Exchange Interaction—M. L. Glasser. 174, 424 (1968)

Dynamic Polarization of Protons in Copper Tutton Salts (Dilute $CuK_4SO_4\cdot 6H_2O$) and Their Spin-Lattice Relaxation Times—J. S. Karra, R. Clarkson, and T. Sato. 175, 479 (1968)

Electron-Spin Susceptibilities of the L quid Binary Alkali Metal Alloys—J. A. Kaeck. 175, 897 (1968)

#### 21.2 Paramagnetic Resonance

Spin Relaxation via Low-Lying Energy Level of $Fe^{2+}$ in MgO—E. L. Wilkinson, R. L. Hartman, and J. G. Castle, Jr. 171, 299 (1968)

Electron-Spin-Resonance Absorption Spectrum of Trivalent Gadolinium in Single-Crystal Calcite—S. A. Marshall and R. A. Serway. 171, 345 (1968)

Effective-Spin Hamiltonian for "Non-Kramers" Doublets—K. A. Mueller. 171, 350 (1968)

Spin-Lattice Relaxation-Time Measurements on $Er^{3+}$-Doped Lanthanum Ethylsulfate—C. R. Viswanathan and G. Kaelin. 171, 992 (1968)

Origin of the Crystal Field in $Ti^{3+}$-Substituted Alums—Gerald F. Dionne and John A. MacKinnon. 172, 325 (1968)

Optical and Electron-Spin-Resonance Studies of the $ICl^-$ $V_K$ Center in KCl:I—Lawrence S. Goldberg and Marvin L. Meistrich. 172, 877 (1968)

Paramagnetic-Resonance Studies of Rare-Earth Impurities in II-VI Compounds—R. K. Watts and W. C. Holton. 173, 417 (1968)

Electron Spin Resonance of Undiluted Salts in the Parallel Configuration—Leonard Yarmus and Allan A. Harkavy. 173, 427 (1968)

Electron Spin Resonance of $Zn(ClO_4)_2\cdot 6H_2O$:$Mn^{2+}$ in a Parallel and Perpendicular Configuration—I. J. Fritz and Leonard Yarmus. 173, 445 (1968)

Transmission Electron Spin Resonance in Dilute Copper-Chromium Alloys—P. Monod and S. Schultz. 173, 645 (1968)

Paramagnetic-Resonance Spectra of $S^-$ Trapped in Alkali Halide Crystals—L. E. Vannotti and J. R. Morton. 174, 448 (1968)

Defects in Irradiated Silicon: Electron Paramagnetic Resonance and Electron-Nuclear Double Resonance of the Arsenic- and Antimony-Vacancy Pairs—Edward L. Elkin and G. D. Watkins. 174, 881 (1968)

Spin Hamiltonian of Two Equivalent Nuclei: Application to the $I_2^-$ Centers—Dirk Schoemaker. 174, 1060 (1968)

Spin Relaxation and Transport in Magnetic Alloys—Peter Fulde and Alan Luther. 175, 337 (1968)

Electron-Nuclear Double Resonance of the Self-Trapped Hole in LiF—Ramayana Gazzinelli and Robert Lee Mieher. 175, 395 (1968)

Electron-Nuclear Double-Resonance Spectrum of the $V_K$ Center in Sodium Fluoride—Daniel F. Daly and Robert Lee Mieher. 175, 412 (1968)

Electron-Nuclear Double-Resonance Study of the Self-Trapped Hole Associated with Lithium in NaF—Isaac L. Bass and Robert Lee Mieher. 175, 421 (1968)

Production of Divalent Thulium in CaO and $SrCl_2$—M. M. Abraham, R. W. Reynolds, and L. A. Boatner. 175, 485 (1968)

Paramagnetic Resonance of $Cr^{3+}$ in the Layer Structure of $NaInS_2$—K. A. Müller and W. Berlinger. 175, 503 (1968)

Defects in Rutile. I. Electron Paramagnetic Resonance of Interstitially Doped $n$-Type Rutile—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1091 (1968)

Magnetic Interactions between Rare-Earth Ions in Insulators. III. EPR Measurements of $Ce^{3+}$ Pair-Interaction Constants in $LaCl_3$—R. J. Birgeneau, M. T. Hutchings, and R. N. Rogers. 175, 1116 (1968)

Theory of Paramagnetic Impurity Spin Resonance in Metals—M. B. Walker. 176, 432 (1968)

Electron Spin Resonance of Free Radicals Formed from Group-IV and Group-V Hydrides in Inert Matrices at Low Temperature—George S. Jackel and Walter Gordy. 176, 443 (1968)

Matrix Perturbations of the ESR of Trapped H, N, P, and As Atoms at 4.2°K—George S. Jackel, William H. Nelson, and Walter Gordy. 176, 453 (1968)

Spin-Lattice Coupling Constants of an $Fe^{3+}$ Ion in MgO—R. R. Sharma. 176, 467 (1968)

Modified Orbach Relaxation Process in a $La(Cl, Br)_3$ Matrix—B. A. Young and H. J. Stapleton. 176, 502 (1968)

Erratum: Magnetic Interactions between Rare-Earth Ions in Insulators. I. Accurate Electron-Paramagnetic-Resonance Determination of $Gd^{3+}$ Pair-Interaction Constants in $LaCl_3$—M. T. Hutchings, R. J. Birgeneau, and W. P. Wolf. [168, 1026 (1968)] 176, 1112 (1968)

#### 21.4 Nuclear Resonance

Interaction of Acoustic Phonons with Nuclear Spins in $KTaO_3$—E. H. Gregory. 171, 365 (1968)

Nuclear Magnetic Resonance in Dilute Alloys of Indium-Lead and Indium-Tin—W. T. Anderson, Jr., F. C. Thatcher, and R. R. Hewitt. 171, 541 (1968)

Solute Knight Shifts in Noble Metals—Lawrence H. Bennett, R. W. Mebs, and R. E. Watson. 171, 611 (1968)

Nuclear Radio-Frequency Spectra of a Series of Tetrahedral Molecules—Irving Ozier, Lawrence M. Crapo, and Sang Soo Lee. 172, 63 (1968)

Nuclear Magnetic Relaxation of $F^{19}$ in Rare-Earth-Doped $LaF_3$—L. Shen. 172, 259 (1968)

Hyperfine Field Spectra of Binary Fe-Co Alloys: Nuclear Magnetic Resonance of $^{57}Fe$ and $^{59}Co$—Mark Rubinstein. 172, 277 (1968)

$S^{33}$ Nuclear Magnetic Resonance in Paramagnetic α-MnS—Kenneth Lee. 172, 284 (1968)

Ground State of the Magnetic Impurity Problem; Nuclear-Magnetic-Resonance Studies of Dilute Copper Alloys—A. J. Heeger, L. B. Welsh, M. A. Jensen, and G. Gladstone. 172, 302 (1968)

Nuclear-Magnetic-Resonance Study of Heavily Nitrogen-Doped Silicon Carbide—Michael N. Alexander. 172, 331 (1968)

Knight Shift in Single-Crystal Mercury—R. W. Weinert and R. T. Schumacher. 172, 711 (1968)

$I^{127}$ Nuclear Quadrupole Resonance in Antiferromagnetic $UI_3$—S. I. Parks and W. G. Moulton. 173, 333 (1968)

Nuclear-Spin-Diffusion Relaxation to a Finite Density of Paramagnetic Impurity Ions—Eiichi Fukushima and Edwin A. Uehling. 173, 366 (1968)

Nuclear Spin-Wave Relaxation and Narrowing of NMR Lines in Ferro- and Antiferromagnets—Peter M. Richards. 173, 581 (1968)

Nuclear-Magnetic-Resonance Studies of $Mn^{55}$ in Ni–Mn Alloys—R. L. Streever. 173, 591 (1968)

Erratum: Dynamical Effects of Deuteron Intrabond Jumping in $KD_2PO_4$—V. Hugo Schmidt. [164, 749 (1967)] 173, 630 (1968)

Effects of Electron–Electron Interactions on Nuclear Spin-Lattice Relaxation Rates and Knight Shifts in Alkali and Noble Metals—Albert Narath and H. T. Weaver. 175, 373 (1968)

Electron-Nuclear Double Resonance of the Self-Trapped Hole in LiF—Ramayana Gazzinelli and Robert Lee Mieher. 175, 395 (1968)

Electron-Nuclear Double-Resonance Spectrum of the $V_K$ Center in Sodium Fluoride—Daniel F. Daly and Robert Lee Mieher. 175, 412 (1968)

Electron-Nuclear Double-Resonance Study of the Self-Trapped Hole Associated with Lithium in NaF—Isaac L. Bass and Robert Lee Mieher. 175, 421 (1968)

Coherent Averaging Effects in Magnetic Resonance—U. Haeberlen and J. S. Waugh. 175, 453 (1968)

Measurement of the Nuclear Spin Diffusion Coefficient in $CaF_2$—G. W. Leppelmeier and J. Jeener. 175, 498 (1968)

Determination of the Electric-Field-Gradient Tensor at the Arsenic Site in $KH_2AsO_4$ by Proton Relaxation Measurements—Wendland Beezhold and Edwin A. Uehling. 175, 624 (1968)

Unitary Theory of Dynamic Polarization of Nuclear Spins in Liquids and Solids—P. Papon, J. L. Motchane, and J. Korringa. 175, 641 (1968)

Erratum: Nuclear Magnetic Resonance and Relaxation of $^{197}Au$ in Gold Metal and $^{109}Ag$ in Gold–Silver Alloys—Albert Narath. [163, 232 (1967)] 175, 696 (1968)

Erratum: Nuclear Magnetic Resonance and Relaxation in Iridium Metal: The Nuclear Magnetic Dipole Moments of $^{191}Ir$ and $^{193}Ir$—Albert Narath. [165, 506 (1968)] 175, 696 (1968)

Nuclear Spin-Lattice Relaxation in Very Dilute Solutions of Orthohydrogen in Parahydrogen—C. E. Miller and M. Lipsicas. 176, 273 (1968)

Nuclear Magnetic Resonance in the Metal $ReO_3$: $^{185}Re$ and $^{187}Re$ Knight Shifts and Spin Relaxation Rates—Albert Narath and D. C. Barham. 176, 479 (1968)

Nuclear-Magnetic-Resonance Study of the Ferroelectric Transitions in $NaH_3(SeO_3)_2$ and $NaD_3(SeO_3)_2$—R. Blinc, J. Stepišnik, and I. Zupančič. 176, 732 (1968)

## 22 SPECTRA OF IONS

Radiative and Multiphonon Relaxation of Rare-Earth Ions in $Y_2O_3$—M. J. Weber. 171, 283 (1968)

Zeeman Study of the Jahn-Teller Effect in the $^3T_{2g}$ State of $Al_2O_3:V^{3+}$—P. J. Stephens and Marian Lowe-Pariseau. 171, 322 (1968)

Optical Spectrum and Zeeman Effect of $CaF_2:Eu^{2+}$—P. Kisliuk, H. H. Tippins, C. A. Moore, and S. A. Pollack. 171, 336 (1968)

Investigations of $4f \leftrightarrow 5d$ Transitions of $Ce^{+3}$ in $CaF_2$—M. Schlesinger and P. W. Whippey. 171, 361 (1968)

Zeeman Splitting of Vibronic Levels for Octahedral Actinide and Lanthanide Complexes, Free and in Crystals—R. A. Satten, D. R. Johnston, and E. Y. Wong. 171, 370 (1968)

Zero-Field Splitting of *S*-State Ions. III. Corrections to Parts I and II and Application to Distorted Cubic Crystals—R. R. Sharma, T. P. Das, and R. Orbach. 171, 378 (1968)

Spin-Lattice Relaxation-Time Measurements on $Er^{3+}$-Doped Lanthanum Ethylsulfate—C. R. Viswanathan and G. Kaelin. 171, 992 (1968)

Effect of Stress on the Trigonal Splittings of $d^3$ Ions in Sapphire ($\alpha$-$Al_2O_3$)—Elsa Feher and M. D. Sturge. 172, 244 (1968)

Nuclear Magnetic Relaxation of $F^{19}$ in Rare-Earth-Doped $LaF_3$—L. Shen. 172, 259 (1968)

Low-Temperature Magnetic Anisotropy in $Al_2O_3:V^{3+}$—Alfred R. Smith and Raymond W. Mires. 172, 265 (1968)

Mössbauer Studies of the $SrTiO_3:Fe^{57}$ System—V. G. Bhide and H. C. Bhasin. 172, 290 (1968)

Mössbauer Effect for $Fe^{57}$ in $Al_2O_3$—Effects of Variety of Heat Treatments—V. G. Bhide and S. K. Date. 172, 345 (1968)

Stable Potential Minima and the Jahn-Teller Interaction—P. Wysling and K. A. Müller. 173, 327 (1968)

Energy Transfer between Chromium Ions in Nonequivalent Sites in $Li_2Ge_7O_{15}$—Richard C. Powell. 173, 358 (1968)

Shielding of Crystal Fields at Rare-Earth Ions—R. M. Sternheimer, M. Blume, and R. F. Peierls. 173, 376 (1968)

Absorption Spectrum of Optically Pumped $Al_2O_3:Cr^{3+}$—J. W. Huang and H. W. Moos. 173, 440 (1968)

Electron Spin Resonance of $Zn(ClO_4)_2 \cdot 6H_2O:Mn^{2+}$ in a Parallel and Perpendicular Configuration—I. J. Fritz and Leonard Yarmus. 173, 445 (1968)

Mössbauer Effect in Europium Alloys—S. Hüfner and J. H. Wernick. 173, 448 (1968)

Erratum: Theory of Magnetically Induced Electric Field Gradients in Cubic $Fe^{2+}$—U. Ganiel and S. Shtrikman. [167, 258 (1968)] 173, 630 (1968)

Magnetic Parameters for the Configuration $f^3$—Hannah Crosswhite, H. M. Crosswhite, and B. R. Judd. 174, 89 (1968)

Multiphonon Orbit-Lattice Relaxation of Excited States of Rare-Earth Ions in Crystals—L. A. Riseberg and H. W. Moos. 174, 429 (1968)

Ground-State Modulation Using Optical Double Resonance in Trivalent Rare-Earth-Doped Single Crystals—L. Esterowitz and E. Chicklis. 174, 463 (1968)

Selection Rules for an Electronic Raman Effect in a Situation where the Appropriate Point Group is a Double Group—J. A. Koningstein. 174, 477 (1968)
Decay Modes with Coherent Resonant-Energy Transfer between Deep Impurities in Solids—R. C. Casella. 174, 830 (1968)
Resonance Energy Transfer in Condensed Media from a Many-Particle Viewpoint—John D. Dow. 174, 962 (1968)
Vibronic Transitions of $Sm^{2+}$ and $Eu^{2+}$ in $SrF_2$ and their Zeeman Effect—E. Cohen and H. J. Guggenheim. 175, 354 (1968)
Production of Divalent Thulium in CaO and $SrCl_2$—M. M. Abraham, R. W. Reynolds, and L. A. Boatner. 175, 485 (1968)
Analysis of the Ground Term of Triply Ionized Terbium in Calcium Tungstate—D. E. Wortman. 175, 488 (1968)
Paramagnetic Resonance of $Cr^{3+}$ in the Layer Structure of $NaInS_2$—K. A. Müller and W. Berlinger. 175, 503 (1968)
Effective Density of Phonon States for $NdCl_3$ from Vibronic Spectra and Applications to Ion-Lattice Interactions—E. Cohen, L. A. Riseberg, and H. W. Moos. 175, 521 (1968)
$4f^n \rightarrow 4f^{n-1}5d$ Spectra of Rare-Earth Ions in Crystals—Eugene Loh. 175, 533 (1968)
Magnetic Interactions between Rare-Earth Ions in Insulators III. EPR Measurements of $Ce^{3+}$ Pair-Interaction Constants in $LaCl_3$—R. J. Birgeneau, M. T. Hutchings, and R. N. Rogers. 175, 1116 (1968)
Spin-Lattice Coupling Constants of an $Fe^{3+}$ Ion in MgO—R. R Sharma. 176, 467 (1968)
Theoretical Study on the Anisotropy of the Spin-Lattice Relaxation for Paramagnetic Ions by MgO Crystal—Santosh Kumar, T. Ray, and D. K. Ray. 176, 489 (1968)
Paraelectric-Resonance Spectroscopy—T. L. Estle. 176, 1056 (1968)
Erratum: Magnetic Interactions between Rare-Earth Ions in Insulators. I. Accurate Electron-Paramagnetic-Resonance Determination of $Gd^{3+}$ Pair-Interaction Constants in $LaCl_3$—M. T. Hutchings, R. J. Birgeneau, and W. P. Wolf. [168, 1026 (1968)] 176, 1112 (1968)

## 23 STIMULATED EMISSION; LASERS AND MASERS (see also 44.4 and 62.4)

Photon Echo in Gaseous Media—M. Scully, M. J. Stephen, and David C. Burnham. 171, 213 (1968)
Erratum: Quantum Theory of Spontaneous Parametric Scattering of Intense Light—T. G. Giallorenzi and C. L. Tang. [166, 225 (1968)] 171, 610 (1968)
Multiphoton Ionization of Atomic Hydrogen in the Ground State—Y. Gontier and M. Trahin. 172, 83 (1968)
Quantum Noise. XI. Multitime Correspondence between Quantum and Classical Stochastic Processes—Melvin Lax. 172, 350 (1968)
Quantum Noise. XIII. Six-Classical-Variable Description of Quantum Laser Fluctuations—Melvin Lax and Horace Yuen. 172, 362 (1968)
Anti-Stokes Generation in Trapped Filaments of Light—C. A. Sacchi, C. H. Townes, and J. R. Lifsitz. 174, 439 (1968)
Quantum Optics. II. Description of a Mode—I. R. Senitzky. 174, 1588 (1968)
Large-Scale Self-Trapping of Optical Beams in the Paraxial Ray Approximation—W. G. Wagner, H. A. Haus, and J. H. Marburger. 175, 256 (1968)
Stimulated Thermal Rayleigh Scattering in Liquids—C. W. Cho, N. D. Foltz, D. H. Rank, and T. A. Wiggins. 175, 271 (1968)
Laser-Induced Instabilities in Raman-Active Media—Keith A. Brueckner and Sadanand S. Rangnekar. 175, 332 (1968)
Symmetrical Formulation of the Quantum Theory of Three-Wave Optical Parametric Interactions—C. Y. She. 176, 461 (1968)
Emission of Radiation from a System of Many Excited Atoms—V. Ernst and P. Stehle. 176, 1456 (1968)

### 23.2 Gas

Theory of Nonlinear Effects in a Gas Laser Amplifier. I. Weak Signals—Andrew Dienes. 174, 400 (1968)
Theory of Nonlinear Effects in a Gas Laser Amplifier. II. Strong Signals—Andrew Dienes. 174, 414 (1968)
Theory of a Single-Mode Gas Laser—Howard Greenstein. 175, 438 (1968)

### 23.4 Solid

Optical Parametric Scattering in Ammonium Dihydrogen Phosphate—Douglas Magde and Herbert Mahr. 171, 393 (1968)
Tuning of PbSe Lasers by Hydrostatic Pressure from 8 to 22 $\mu$—J. M. Besson, William Paul, and A. R. Calawa. 173, 699 (1968)

## 24 RECOILLESS ABSORPTION AND GAMMA-RAY EMISSION

Isomer Shift and Hyperfine Splittings of the 59.6-keV Mössbauer Resonance in $^{237}Np$—B. D. Dunlap, G. M. Kalvius, S. L. Ruby, M. B. Brodsky, and D. Cohen. 171, 316 (1968)
Hyperfine Structure of $Au^{197}$ in Fe Measured with the Mössbauer Effect—R. L. Cohen. 171, 343 (1968)
Mössbauer-Effect Measurements in Iron at High Pressures—W. H. Southwell, D. L. Decker, and H. B. Vanfleet. 171, 354 (1968)
Effect of Pressure on the Isomer Shift of $Fe^{57}$ in the bcc Phase—J. A. Moyzis, Jr., and H. G. Drickamer. 171, 389 (1968)
Resonant Absorption in the Presence of Faraday Rotation—M. Blume and O. C. Kistner. 171, 417 (1968)
Time Dependence of Mössbauer Scattered Radiation—P. Thieberger, J. A. Moragues, and A. W. Sunyar. 171, 425 (1968)
Mössbauer Faraday Effect—R. M. Housley and U. Gonser. 171, 480 (1968)
Mössbauer Measurements with $K^{40}$—P. K. Tseng, S. L. Ruby, and D. H. Vincent. 172, 249 (1968)
Spin Relaxation in Mössbauer Spectra of Magnetically Ordered Systems—Lionel M. Levinson and Marshall Luban. 172, 268 (1968)
Mössbauer Studies of the $SrTiO_3$:$Fe^{57}$ System—V. G. Bhide and H. C. Bhasin. 172, 290 (1968)
Quadrupolar Hyperfine Anisotropy in $Fe(NH_4SO)_2 \cdot 6H_2O$ and Its Comparison with the Magnetic Susceptibility—R. Ingalls, K. Ono, and Louis Chandler. 172, 295 (1968)
Influence of Radio-Frequency Magnetic Fields on the Mössbauer Effect in Magnetic $Co^{57}$ Sources—Gilbert J. Perlow. 172, 319 (1968)
Mössbauer Effect for $Fe^{57}$ in $Al_2O_3$—Effects of Variety of Heat Treatments—V. G. Bhide and S. K. Date. 172, 345 (1968)
Magnetically Induced Quadrupole Interactions in $FeCr_2S_4$—Gilbert R. Hoy and K. P. Singh. 172, 514 (1968)
Temperature Dependence of the $^{57}Fe$ hfs in the Ordered Alloys $FePd_3$ and FePd near the Curie Temperature—G. Longworth. 172, 572 (1968)

Effect of Pressure on $f$ Number and Isomer Shift for $Fe^{57}$ in Cu, V, and Ti—J. A. Moyzis, Jr., G. DePasquali, and H. G. Drickamer. 172, 665 (1968)

Low-Temperature Anharmonicity in $FeCl_2$—D. P. Johnson and J. G. Dash. 172, 983 (1968)

Determination of the Nuclear Quadrupole Moment of $Fe^{57m}$ from $\alpha$-$Fe_2O_3$ Data—J. O. Artman, A. H. Muir, Jr., and H. Wiedersich. 173, 337 (1968)

Mössbauer Effect in Europium Alloys—S. Hüfner and J. H. Wernick. 173, 448 (1968)

Magnetic Properties of the Planar Antiferromagnet $Rb_2FeF_4$—G. K. Wertheim, H. J. Guggenheim, H. J. Levinstein, D. N. E. Buchanan, and R. C. Sherwood. 173, 614 (1968)

Coulomb-Recoil-Implantation Mössbauer Experiments with $^{73}Ge$—Gordon Czjzek, J. L. C. Ford, Jr., John C. Love, Felix E. Obenshain, and Horst H. F. Wegener. 174, 331 (1968)

Temperature-Dependent Isomer Shift and Anharmonic Binding of $Sn^{119}$ in $Nb_3Sn$ from Mössbauer-Effect Measurements—J. S. Shier and R. D. Taylor. 174, 346 (1968)

Stochastic Theory of Line Shape: Generalization of the Kubo-Anderson Model—M. Blume. 174, 351 (1968)

Direct Observation of Solid-State Diffusion Using the Mössbauer Effect—Robert C. Knauer and James G. Mullen. 174, 711 (1968)

Nuclear Properties and Magnetic Hyperfine Interaction of $Os^{189}$—B. Persson, H. Blumberg, and M. Bent. 174, 1509 (1968)

Mössbauer Effect of $I^{127}$ and $Te^{125}$ in Iodine, Tellurium, and Antimony Compounds—Peter Jung and Werner Triftshäuser. 175, 512 (1968)

Correlation between Mössbauer Resonance Strength and Second-Order Doppler Shift: Estimate of Zero-Point Velocity—R. Dean Taylor and Paul P. Craig. 175, 782 (1968)

## 25 POSITRON ANNIHILATION (see also 15)

Assumption-Independent Single-Particle Wave Function for Positrons in Solids: Applications to Angular Distributions in Al and Si—D. Stroud and H. Ehrenreich. 171, 399 (1968)

Single-Quantum Annihilation of Positrons—Hiromasa Mazaki, Masatsugu Nishi, and Sakae Shimizu. 171, 408 (1968)

Radiationless Annihilation of Positrons in Lead—Sakae Shimizu, Takeshi Mukoyama, and Yasuyuki Nakayama. 173, 405 (1968)

Electric Field Dependence of Positronium Formation in Matter—Werner Brandt and Howard Feibus. 174, 454 (1968)

Positron Annihilation in Semiconductors—R. Fieschi, A. Gainotti, C. Ghezzi, and M. Manfredi. 175, 383 (1968)

Positron Annihilation in Yttrium and Zirconium—R. P. Gupta and T. L. Loucks. 176, 848 (1968)

## 26 ELECTRON AND ION EMISSION (see also 42.2)

Photoelectric Cross Sections in the keV Range—H. Brysk and C. D. Zerby. 171, 292 (1968)

Relativistic Study of $KL_1L_1$ Auger Transition Probabilities—Dipankar Chattarji and Benoy Talukdar. 174, 44 (1968)

Mass Dependence of the Angular Distribution of Charged-Particle Emission from Crystals: Transition to the Classical Limit—R. E. De Wames, W. F. Hall, and G. W. Lehman. 174, 392 (1968)

Metastable Atoms and Molecules. III. Metastable Impacts on Surfaces with Various Work Functions—R. N. Varney. 175, 98 (1968)

Critical-Point Structure in Photoelectric Emission Energy Distributions—Evan O. Kane. 175, 1039 (1968)

## 27 RANGE AND ENERGY LOSS (see also 13 and 43.2)

Role of Electronic Structure in Determining the Charges of Fast Ions in Matter—R. L. Wolke. 171, 301 (1968)

Charged Component of 1-GeV Electron Showers in Lead—D. J. Drickey, J. R. Kilner, and D. Benaksas. 171, 310 (1968)

Erratum: Electron Longitudinal Depolarization with Great Energy Loss—L. Braicovich, B. De Michelis, and A. Fasana. [164, 1360 (1967)] 171, 1330 (1968)

Stopping Powers of $S^{32}$, $Cl^{35}$, $Br^{79}$, and $I^{127}$ Ions in Mylar—T. E. Pierce, W. W. Bowman, and Marshall Blann. 172, 287 (1968)

Effects Seen in the Passage of Positively Charged Ions through Single Crystals—R. E. Holland and D. S. Gemmell. 173, 344 (1968)

Stopping Powers and Ranges of 5–90-MeV $S^{32}$, $Cl^{35}$, $Br^{79}$, and $I^{127}$ Ions in $H_2$, He, $N_2$, Ar, and Kr: A Semiempirical Stopping Power Theory for Heavy Ions in Gases and Solids—T. E. Pierce and Marshall Blann. 173, 390 (1968)

Partition of the Average Energy Deposited in Germanium as a Function of Incident Neutron Energy—Allan R. Sattler and Frederick L. Vook. 173, 435 (1968)

Periodic Dependence of the Electronic Stopping Cross Section for Energetic Heavy Ions in Solids—Ahmed H. Elhoshy and James F. Gibbons. 173, 454 (1968)

Alpha-Particle Ionization in Argon-Methane Mixtures and the Energy Dependence of the Ion Pair-Formation Energy—William P. Jesse. 174, 173 (1968)

Mass Dependence of the Angular Distribution of Charged-Particle Emission from Crystals: Transition to the Classical Limit—R. E. De Wames, W. F. Hall, and G. W. Lehman. 174, 392 (1968)

Scattering of $\beta$ Radiation on a Thick Foil: Production of Transverse Polarization—L. Braicovich, B. De Michelis, and A. Fasana. 174, 460 (1968)

Meson Captures in Solids—M. Y. Au-Yang and Marvin L. Cohen. 174, 468 (1968)

Quantum Treatment of Multiple Real Transitions—J. C. Ashley and R. H. Ritchie. 174, 1572 (1968)

Range and $dE/dx$ of C, N, O, F, and Ne in Be and C from 500 keV to 2 MeV—W. K. Chu, P. D. Bourland, K. H. Wang, and D. Powers. 175, 342 (1968)

Stopping Power of the Elements $Z = 20$ Through $Z = 30$ for 5–12-MeV Protons and Deuterons—H. H. Andersen, C. C. Hanke, H. Simonsen, H. Sørensen, and P. Vajda. 175, 389 (1968)

Stopping Power and Luminescent-Response Calculation for Channeling in NaI(Tl) and CsI(Tl)—Myron Luntz and Ralph H. Bartram. 175, 468 (1968)

Mean Excitation Potential of Light Compounds—C. Tschalär and Hans Bichsel. 175, 476 (1968)

Channeling in Zinc-Blende Lattices: Energy-Loss Studies for Hydrogen and Helium Ions in InAs, GaSb, AlSb, and InSb—Allan R. Sattler and Frederick L. Vook. 175, 526 (1968)

Characteristic Energy Losses of 8-keV Electrons in Liquid Al, Bi, In, Ga, Hg, and Au—C. J. Powell. 175, 972 (1968)

Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10–180 MeV—C. D. Moak, H. O. Lutz, L. B. Bridwell, L. C. Northcliffe, and S. Datz. 176, 427 (1968)

Energy-Loss Straggling of Protons in Silicon—J. J. Kolata, T. M. Amos, and Hans Bichsel. 176, 484 (1968)
Differential Range Study of $(\alpha,xn)$ Reactions of Copper—N. T. Porile and I. Fujiwara. 176, 1166 (1968)
Relativistic Energy Loss by Ionization in Nuclear Emulsions—F. J. Congel and P. J. McNulty. 176, 1615 (1968)
Erratum: Ionization Loss at Relativistic Velocities—C. A. Nicoletta, P. J. McNulty, and P. L. Jain. [164, 1693 (1967)] 176, 2167 (1968)

# 30 FLUIDS, THERMODYNAMICS, AND RELATED TOPICS

## 31 GENERAL THEORY OF FLUIDS (see also 41.1 and 51.4)

Continuum Theory of Thomson Scattering—B. Samuel Tanenbaum. 171, 215 (1968)
Variance of $H$ in the Bijl-Feynman Description of an Elementary Excitation—Tollie Davison and Eugene Feenberg. 171, 221 (1968)
Structure of Correlation Functions near the Critical Point—Gerald L. Jones. 171, 243 (1968)
Correlation Functions in Ring-Diagram Approximation—A. Isihara. 172, 166 (1968)
Correlation Functions as Hydrodynamic Green's Functions—James W. Dufty and James A. McLennan. 172, 176 (1968)
Finite Geometries and Ideal Bose Gases—David A. Krueger. 172, 211 (1968)
Microscopic Quantum Hydrodynamics for Interacting Bose Systems—Robert Fanelli and R. E. Struzynski. 173, 248 (1968)
Correlated Motions in Simple Classical Liquids—William C. Kerr. 174, 316 (1968)
Theory of the Dynamics of Simple Fluids for Large Spatial Gradients and Long Memory—Robert A. Piccirelli. 175, 77 (1968)
A Parametric Approach to the Ground-State Energy of an Electron Gas—M. S. Becker, A. A. Broyles, and Tucson Dunn. 175, 224 (1968)
On the Theory of Quantized Vortices—G. V. Chester, R. Metz, and L. Reatto. 175, 275 (1968)
Coupling of Density and Spin Fluctuations to Quasiparticles in a Fermi Liquid—D. J. Amit, J. W. Kane, and H. Wagner. 175, 313 (1968)
Logarithmic Terms in the Specific Heat of a Normal Fermi Liquid—D. J. Amit, J. W. Kane, and H. Wagner. 175, 326 (1968)

## 32 FLUID STRUCTURE, PROPERTIES, AND DYNAMICS (see also 33 and 35.5)

Time Evolution of the Total Distribution Function of a One-Dimensional System of Hard Rods—J. L. Lebowitz, J. K. Percus, and J. Sykes. 171, 224 (1968)
Liquid Structure Factor of Ground-State $He^4$—N. Mihara and R. D. Puff. 174, 221 (1968)
Convergents to Infinite Series in Turbulence Theory—Robert H. Kraichnan. 174, 240 (1968)
Velocity of Sound at 1 MHz Near the $He^4$ Critical Point—R. C. Williamson and C. E. Chase. 176, 285 (1968)

### 32.2 Gases

Padé-Approximant Calculation of the Nonretarded van der Waals Coefficients for Two and Three Helium Atoms—K. T. Tang and M. Karplus. 171, 70 (1968)
Photon Echo in Gaseous Media—M. Scully, M. J. Stephen, and David C. Burnham. 171, 213 (1968)
Rotational Correlation Functions in Neutron Scattering by Molecular Gases—Ashok K. Agrawal and Sidney Yip. 171, 263 (1968)
Transport Coefficients Near the Consolute Temperature of a Binary Liquid Mixture—Jack Swift. 173, 257 (1968)
Homogeneity of the Correlation Length in the Critical Region—G. Stell. 173, 314 (1968)

### 32.4 Liquids

Investigation of Rayleigh Wings and Brillouin-Stimulated Scattering in Liquids—Marguerite Denariez and Georges Bret. 171, 160 (1968)
Erratum: Effect of Angular Correlation on Nonlinear Refractive Index of Liquids—M. Takatsuji. [165, 171 (1968)] 172, 241 (1968)
Brillouin Scattering in Relaxing Liquids—A. B. Bhatia and E. Tong. 173, 231 (1968)
Neutron Diffraction by Liquid Zinc—B. A. Dasannacharya, Q. O. Navarro, H. Ibarra, S. Chatraphorn, and G. B. Lee. 173, 241 (1968)
Velocity of Sound and Compressibility in Liquid Metals—P. Ascarelli. 173, 271 (1968)
Mobility of Negative Ions Along Vortices in Rotating Superfluid Helium—R. L. Douglass. 174, 255 (1968)
Ultrasonic Attenuation in Liquid Metals—K. C. Sharma. 174, 309 (1968)
Measurement of the Coherent Neutron Scattering Amplitude of Deuterium, Mercury, and Fluorine by Mirror Reflection—W. Bartolini, R. E. Donaldson, and D. J. Groves. 174, 313 (1968)
Correlated Motions in Simple Classical Liquids—William C. Kerr. 174, 316 (1968)
Erratum: Electric Properties of $n$-Type Liquid Alloys of Thallium and Tellurium—Melvin Cutler and Marshall B. Field. [169, 632 (1968)] 174, 1082 (1968)
Large-Scale Self-Trapping of Optical Beams in the Paraxial Ray Approximation—W. G. Wagner, H. A. Haus, and J. H. Marburger. 175, 256 (1968)
Theory of Strongly Interacting Quantum Liquids. I. Formulation—W. L. McMillan. 175, 266 (1968)
Stimulated Thermal Rayleigh Scattering in Liquids—C. W. Cho, N. D. Foltz, D. H. Rank, and T. A. Wiggins. 175, 271 (1968)
Laser-Induced Instabilities in Raman-Active Media—Keith A. Brueckner and Sadanand S. Rangnekar. 175, 332 (1968)
Characteristic Energy Losses of 8-keV Electrons in Liquid Al, Bi, In, Ga, Hg, and Au—C. J. Powell. 175, 972 (1968)
Unified Approximation for the Velocity Autocorrelation Function and the Structure Function of a Simple Liquid—Leon Glass and Stuart A. Rice. 176, 239 (1968)
Superfluid Phase Transitions in One and Two Dimensions—Allan Widom. 176, 254 (1968)
Nuclear Spin-Lattice Relaxation in Very Dilute Solutions of Orthohydrogen in Parahydrogen—C. E. Miller and M. Lipsicas. 176, 273 (1968)
Ultrasonic Attenuation in Liquid Metals. II. Dense-Gas Formulation—K. C. Sharma. 176, 319 (1968)
Study of Exciton Dynamics in a Simple Liquid—Sighart Fischer and Stuart A. Rice. 176, 409 (1968)
Hall Measurements in Liquid Thallium-Tellurium—James M. Donally and Melvin Cutler. 176, 1003 (1968)

## 33 THERMODYNAMICS AND STATISTICAL PHYSICS (see also 42.4)

Three-Particle Effects in the Pair Distribution Function for $He^4$ Gas—Harry F. Jordan and Lloyd D. Fosdick. 171, 128 (1968)

Thermal Diffusivity of $CO_2$ in the Critical Region—H. L. Swinney and Herman Z. Cummins. 171, 152 (1968)

Monte Carlo Study of a Hydrogenous Plasma near the Ionization Temperature—A. A. Barker. 171, 186 (1968)

Theory of Magnetized Solid Helium Three—Louis Goldstein. 171, 194 (1968)

Structure of Correlation Functions near the Critical Point—Gerald L. Jones. 171, 243 (1968)

Correlation Functions in Ring-Diagram Approximation—A. Isihara. 172, 166 (1968)

Correlation Functions as Hydrodynamic Green's Functions—James W. Dufty and James A. McLennan. 172, 176 (1968)

Finite Geometries and Ideal Bose Gases—David A. Krueger. 172, 211 (1968)

Coherent Phonon States and Long-Range Order in Two-Dimensional Bose Systems—Gordon Lasher. 172, 224 (1968)

Analytic Free Energy: A Basis for Scaling Laws—Michael H. Coppersmith. 172, 230 (1968)

Shape-Dependent Thermodynamic Quantities in Magnetic Systems with Dipole Interaction—Heinz Horner. 172, 535 (1968)

Critical-Point Behavior of a Model Describing a System of Interacting Fermions—S. Gartenhaus and G. Stranahan. 173, 260 (1968)

Velocity of Sound and Compressibility in Liquid Metals—P. Ascarelli. 173, 271 (1968)

Relativistic Thermodynamics of Moving Systems—N. G. van Kampen. 173, 295 (1968)

Homogeneity of the Correlation Length in the Critical Region—G. Stell. 173, 314 (1968)

Quantum Theory of an Electron Gas in Intense Magnetic Fields—Vittorio Canuto and Hong-Yee Chiu. 173, 1210 (1968)

Thermodynamic Properties of a Magnetized Fermi Gas—Vittorio Canuto and Hong-Yee Chiu. 173, 1220 (1968)

Magnetic Moment of a Magnetized Fermi Gas—Vittorio Canuto and Hong-Yee Chiu. 173, 1229 (1968)

Statistical Mechanics of Monolayers of Bose and Fermi Atoms Adsorbed on Crystalline Surfaces—J. G. Dash and Michael Bretz. 174, 247 (1968)

Mean-Occupation-Number Formalism in Statistical Mechanics—J. M. Luttinger. 174, 263 (1968)

Ultrasonic Attenuation in Liquid Metals—K. C. Sharma. 174, 309 (1968)

Statistical-Mechanical Theory of Resonance Susceptibility in Heisenberg Antiferromagnetism—Jeremiah H. Barry. 174, 531 (1968)

Bounds for the Isothermal, Adiabatic, and Isolated Static Susceptibility Tensors—R. M. Wilcox. 174, 624 (1968)

Theory of the Dynamics of Simple Fluids for Large Spatial Gradients and Long Memory—Robert A. Piccirelli. 175, 77 (1968)

Exact Inversion of the Fugacity-Density Relation for Ideal Quantum Gases—A. Leonard. 175, 221 (1968)

Quantum-Mechanical Description of Two Coupled Harmonic Oscillators—Lee E. Estes, Thomas H. Keil, and Lorenzo M. Narducci. 175, 286 (1968)

Magnon Density Fluctuations in the Heisenberg Ferromagnet—George F. Reiter. 175, 631 (1968)

Unified Approximation for the Velocity Autocorrelation Function and the Structure Function of a Simple Liquid—Leon Glass and Stuart A. Rice. 176, 239 (1968)

Crystalline Order in Two Dimensions—N. D. Mermin. 176, 250 (1968)

Shell Structure and the Thomas-Fermi Equation of State—J. W. Zink. 176, 279 (1968)

Some Remarks on Perturbation Theory and Critical Phenomena—P. T. Herman and J. R. Dorfman. 176, 295 (1968)

Generalized Scaling and the Critical Eigenvector in Ideal Bose Condensation—Martin J. Cooper and Melville S. Green. 176, 302 (1968)

Phase Separation in Isotopic Fermi-Bose Mixtures—J. M. J. van Leeuwen and E. G. D. Cohen. 176, 385 (1968)

Hydrodynamics and Time-Correlation Functions—James W. Dufty. 176, 398 (1968)

Erratum: Finite Electronic Partition Function from Screened Coulomb Interactions—Carl A. Rouse. [163, 62 (1967)] 176, 423 (1968)

Electron Correlations at Metallic Densities—K. S. Singwi, M. P. Tosi, R. H. Land, and A. Sjölander. 176, 589 (1968)

Free Energy of Interacting Magnetic Dipoles—Robert B. Griffiths. 176, 655 (1968)

Spherical Model as the Limit of Infinite Spin Dimensionality—H. E. Stanley. 176, 718 (1968)

Qualitative Temperature and Volume Dependence of the Thermal Expansion Coefficient of Solids—Duane C. Wallace. 176, 827 (1968)

Density Matrices in the Many-Body Problem—P. Gluck. 176, 1534 (1968)

### 33.5 Irreversible, Transport, and Stochastic Processes (see also 45)

"Boltzmann Statistics" without Statistics in the Classical Harmonic Lattice—Leon Gunther. 171, 210 (1968)

Time Evolution of the Total Distribution Function of a One-Dimensional System of Hard Rods—J. L. Lebowitz, J. K. Percus, and J. Sykes. 171, 224 (1968)

Quantum Theory of Electrical Transport in a Magnetic Field. I—R. B. Thomas, Jr. 171, 827 (1968)

Voltage Fluctuations in a Diode—H. Hurwitz, Jr. 172, 207 (1968)

Brillouin Scattering in Relaxing Liquids—A. B. Bhatia and E. Tong. 173, 231 (1968)

Transport Coefficients Near the Consolute Temperature of a Binary Liquid Mixture—Jack Swift. 173, 257 (1968)

Exact Classical Nonequilibrium Statistical-Mechanical Analysis of the Finite Ideal Gas—Arthur Hobson and David N. Loomis. 173, 285 (1968)

Convergents to Infinite Series in Turbulence Theory—Robert H. Kraichnan. 174, 240 (1968)

Transport Theory of a Partially Degenerate Plasma—Martin Lampe. 174, 276 (1968)

Stochastic Theory of Line Shape: Generalization of the Kubo-Anderson Model—M. Blume. 174, 351 (1968)

Current Fluctuations in the Acoustoelectric Steady State—Lionel Friedman. 174, 737 (1968)

Theory of the Dynamics of Simple Fluids for Large Spatial Gradients and Long Memory—Robert A. Piccirelli. 175, 77 (1968)

Multiple Scattering and the Inverse Albedo Problem—S. Pahor. 175, 218 (1968)

Transport Theory in Strong Magnetic Fields—H. F. Budd. 175, 241 (1968)

Solution of Boltzmann Equation for Degenerate Fermi Systems—V. J. Emery. 175, 251 (1968)

Theory of Strongly Interacting Quantum Liquids. I. Formulation—W. L. McMillan. 175, 266 (1968)

Time-Dependent Behavior of a Class of Nonequilibrium Radiating Systems—R. J. Gelinas. 175, 300 (1968)

Unitary Theory of Dynamic Polarization of Nuclear Spins in Liquids and Solids—P. Papon, J. L. Motchane, and J. Korringa. 175, 641 (1968)
Superfluid Phase Transitions in One and Two Dimensions—Allan Widom. 176, 254 (1968)
Conductivity of a Plasma in a Steady Magnetic Field. II—T. Pradhan and B. Dasgupta. 176, 309 (1968)
Ultrasonic Attenuation in Liquid Metals. II. Dense-Gas Formulation—K. C. Sharma. 176, 319 (1968)
Low Excited States and Statistical and Transport Properties of Liquid $He^3$—Hing-Tat Tan and E. Feenberg. 176, 370 (1968)
Hydrodynamics and Time-Correlation Functions—James W. Dufty. 176, 398 (1968)

## 34 LIQUID AND SOLID HELIUM (see also 31)

Phonon-Quasiparticle Interactions in Dilute Solutions of $He^3$ in Superfluid $He^4$. II. Phonon Boltzmann Equation and First Viscosity—Gordon Baym and W. F. Saam. 171, 172 (1968)
Ion Mobility Discontinuities in Superfluid Helium: A Test of the Huang-Olinto Theory—D. L. Goodstein, U. Buontempo, and M. Cerdonio. 171, 181 (1968)
Theory of Magnetized Solid Helium Three—Louis Goldstein. 171, 194 (1968)
Mobility of Positive and Negative Charges in $^3He$ at the Critical Point—R. Cantelli, I. Modena, and F. P. Ricci. 171, 236 (1968)
Liquid $^3He$. II. Three-Body Correlations and their Contribution to the Binding Energy—E. Østgaard. 171, 248 (1968)
Effect of the Gravitational Field on the Superfluid Transition in $He^4$—Guenter Ahlers. 171, 275 (1968)
Diffusion Coefficients and Nuclear Magnetic Susceptibility of Dilute $He^3$–He II Solutions—J. E. Opfer, K. Luszczynski, and R. E. Norberg. 172, 192 (1968)
Coherent Phonon States and Long-Range Order in Two-Dimensional Bose Systems—Gordon Lasher. 172, 224 (1968)
Microscopic Quantum Hydrodynamics for Interacting Bose Systems—Robert Fanelli and R. E. Struzynski. 173, 248 (1968)
Vibrational Modes of a Negative Ion in Liquid Helium—V. Celli, Morrel H. Cohen, and M. J. Zuckerman. 173, 253 (1968)
Critical-Point Behavior of a Model Describing a System of Interacting Fermions—S. Gartenhaus and G. Stranahan. 173, 260 (1968)
Measurement of the Density Maximum of $He^4$ at Saturated Vapor Pressure—M. Barmatz and I. Rudnick. 173, 275 (1968)
Phase Separation in $He^3$ -$He^4$ Mixtures Observed with Slow Neutrons—R. I. Schermer, L. Passell, and D. C. Rorer. 173, 277 (1968)
Low Temperature Measurements of the $He^3$ and $He^4$ Melting Curves—Carl R. Zeisse. 173, 301 (1968)
Phonon-Quasiparticle Interactions in Dilute Solutions of $He^3$ in Superfluid $He^4$: III. Attenuation of First Sound Above 0.2°K—Gordon Baym, W. F. Saam, and C. Ebner. 173, 306 (1968)
Liquid Structure Factor of Ground-State $He^4$—N. Mihara and R. D. Puff. 174, 221 (1968)
Spin Waves in $He^3$ in the Paramagnon Model—Shang-keng Ma, M. T. Béal-Monod, and Donald R. Fredkin. 174, 227 (1968)
Statistical Mechanics of Monolayers of Bose and Fermi Atoms Adsorbed on Crystalline Surfaces—J. G. Dash and Michael Bretz. 174, 247 (1968)
Mobility of Negative Ions Along Vortices in Rotating Superfluid Helium—R. L. Douglass. 174, 255 (1968)
Phonon Spectrum of hcp $He^4$—V. J. Minkiewicz, T. A. Kitchens, F. P. Lipschultz, R. Nathans, and G. Shirane. 174, 267 (1968)
Superfluid Helmholtz Resonators—M. Kriss and I. Rudnick. 174, 326 (1968)
Investigation of a New Kind of Energetic Neutral Excitation in Superfluid Helium—C. M. Surko and F. Reif. 175, 229 (1968)
Theory of Strongly Interacting Quantum Liquids. I. Formulation—W. L. McMillan. 175, 266 (1968)
On the Theory of Quantized Vortices—G. V. Chester, R. Metz, and L. Reatto. 175, 275 (1968)
Calculation of the Self-Consistent Phonon Spectrum of hcp $He^4$—N. S. Gillis, T. R. Koehler, and N. R. Werthamer. 175, 1110 (1968)
Helium Drag in the Theory of Impurity Mobility in Liquid Helium—M. Bailyn and R. Lobo. 176, 222 (1968)
Concentration-Dependent Polarization in $He^3$-$He^4$ Solutions—L. J. Campbell. 176, 225 (1968)
Formation of Nonlocalized Vacancies in bcc $He^3$—J. H. Hetherington. 176, 231 (1968)
Superfluid Phase Transitions in One and Two Dimensions—Allan Widom. 176, 254 (1968)
Velocity of Sound at 1 MHz Near the $He^4$ Critical Point—R. C. Williamson and C. E. Chase. 176, 285 (1968)
Crystalline Transformation of Helium Three—Louis Goldstein. 176, 311 (1968)
Electronic Bubble States in Liquid Helium—W. Beall Fowler and D. L. Dexter. 176, 337 (1968)
Liquid $^3He$. III. The Binding Energy and Other Properties at Zero Temperature—E. Østgaard. 176, 351 (1968)
Low Excited States and Statistical and Transport Properties of Liquid $He^3$—Hing-Tat Tan and E. Feenberg. 176, 370 (1968)
Phase Separation in Isotopic Fermi-Bose Mixtures—J. M. J. van Leeuwen and E. G. D. Cohen. 176, 385 (1968)
Superfluid Fraction of Liquid Helium Contained in Porous Vycor Glass—J. C. Fraser and I. Rudnick. 176, 421 (1968)

## 35 PLASMAS (see also 41.1)

Correlation Function in a Plasma at Zero Particle Separation—B. Davies and R. G. Storer. 171, 150 (1968)
Monte Carlo Study of a Hydrogenous Plasma near the Ionization Temperature—A. A. Barker. 171, 186 (1968)
Effect of Toroidal Magnetic Field on Low-Frequency Plasma Instabilities in a Multipole Machine—D. K. Bhadra. 171, 188 (1968)
Continuum Theory of Thomson Scattering—B. Samuel Tanenbaum. 171, 215 (1968)
Exact Lower Bounds for Some Equilibrium Properties of a Classical One-Component Plasma—N. D. Mermin. 171, 272 (1968)
Resonance Scattering and the Drift Motion of Electrons Through Gases—Lothar Frommhold. 172, 118 (1968)
Nonlinear Effects in Plasma Resonance—Hulbert C. S. Hsuan. 172, 137 (1968)
Convergence of the Two-Component Plasma Correlation Function—Y. C. Lee, D. L. Lin, and Ta-You Wu. 172, 145 (1968)
Measurements of the Stark Broadening of Two Neutral Helium Lines in a Plasma—J. R. Greig, C. P. Lim, G. A. Moo-Young, G. Palumbo, and Hans R. Griem. 172, 148 (1968)
Measurement of Volume Recombination Coefficients in Highly Ionized Alkali Plasmas—S. von Goeler, R. W. Motley, and R. Ellis. 172, 162 (1968)

Wave Coupling Across a Shock Wave in a Fully Ionized Gas—Samuel H. Francis and David Kahn. 172, 181 (1968)

Erratum: Kinetic Equation for Drifted Electron Plasma—N. Tzoar. [162, 123 (1967)] 172, 241 (1968)

Reactions of $H^+$ in $H_2$ and $D^+$ in $D_2$: Mobilities of Hydrogen and Alkali Ions in $H_2$ and $D_2$ Gases—T. M. Miller, J. T. Moseley, D. W. Martin, and E. W. McDaniel. 173, 115 (1968)

Measured Shifts of Cesium Atomic Lines—Correlation with Electron Density Derived from Widths—R. F. Majkowski and R. J. Donohue. 173, 177 (1968)

Improved Stark Profile Calculations for the Hydrogen Lines Hα, Hβ, Hγ, and Hδ—P. Kepple and Hans R. Griem. 173, 317 (1968)

The Possibility of Producing a Dense Thermonuclear Plasma by an Intense Field Emission Discharge—F. Winterberg. 174, 212 (1968)

Transport Theory of a Partially Degenerate Plasma—Martin Lampe. 174, 276 (1968)

Asymptotic Behavior of the Pair Distribution Function of a Classical Electron Gas—D. J. Mitchell and B. W. Ninham. 174, 280 (1968)

Kinetic Equations for Turbulent Plasmas. I. Quasilinear Theory—Setsuo Ichimaru. 174, 289 (1968)

Kinetic Equations for Turbulent Plasmas. II. Fluctuation Spectrum—Setsuo Ichimaru. 174, 300 (1968)

Light Scattering from a Plasma in a Magnetic Field—P. M. Platzman, P. A. Wolff, and N. Tzoar. 174, 489 (1968)

Shear Stabilization of a Collision-Dominated Plasma—J. F. Reynolds and E. H. Holt. 175, 205 (1968)

Time-Dependent Behavior of a Class of Nonequilibrium Radiating Systems—R. J. Gelinas. 175, 300 (1968)

Contribution of Perturber Radiation to the Shapes of Spectral Lines Broadened by Electron Impacts—D. D. Burgess. 176, 150 (1968)

Relativistic Corrections to the Light-Scattering Spectrum of a Plasma—O. Theimer and J. E. Sollid. 176, 198 (1968)

Linear Stark Broadening in High-Density Lithium Plasma—B. Ya'akobi. 176, 227 (1968)

Conductivity of a Plasma in a Steady Magnetic Field. II—T. Pradhan and B. Dasgupta. 176, 309 (1968)

Radial Distribution Function for a Quantum Plasma—R. G. Storer. 176, 326 (1968)

Resonant Four-Wave Interaction of Electron-Plasma Oscillations—R. C. Davidson. 176, 344 (1968)

### 35.5 Gas Discharges (see also 13)

Spin Exchange between Optically Oriented Metastable Helium Atoms and Thermal Electrons in a Flowing Afterglow—L. D. Schearer. 171, 81 (1968)

Classical and Anomalous Diffusion of an Afterglow Plasma—Klaus H. Geissler. 171, 179 (1968)

Energy Distribution Function for Helium—S. O. Elkomoss. 172, 153 (1968)

Recombination, Attachment, and Ambipolar Diffusion of Electrons in Photo-Ionized NO Afterglows—Charles S. Weller and Manfred A. Biondi. 172, 198 (1968)

Erratum: Recombination of Electrons and Molecular Helium Ions—Gunthard K. Born. [169, 155 (1968)] 173, 325 (1968)

Temperature Dependence of the Electron - $O_2^+$-Ion Recombination Coefficient—W. H. Kasner and Manfred A. Biondi. 174, 139 (1968)

Calculation of the Dependence of Emitted Light on Charge Density for Two-Electron Collisional-Radiative Recombination in the Hydrogenic Approximation—C. B. Collins. 175, 160 (1968)

Measurements of Photon Correlations in Partially Coherent Light—D. B. Scarl. 175, 1661 (1968)

Electron-Temperature Dependence of Electron-Ion Recombination in Argon—F. J. Mehr and Manfred A. Biondi. 176, 322 (1968)

Ion Energies at the Cathode for Conduction Through Rarefied Gases—D. R. Schoonover. 176, 331 (1968)

### 36 ATMOSPHERIC PHYSICS (see also 61.2)

Temperature Dependence of the Electron - $O_2^+$-Ion Recombination Coefficient—W. H. Kasner and Manfred A. Biondi. 174, 139 (1968)

## 40 SOLIDS

### 41 COLLECTIVE EFFECTS AND CRITICAL PHENOMENA (see also 4(6-9).1)

Resonance Energy Transfer in Condensed Media from a Many-Particle Viewpoint—John D. Dow. 174, 962 (1968)

Generalized Scaling and the Critical Eigenvector in Ideal Bose Condensation—Martin J. Cooper and Melville S. Green. 176, 302 (1968)

Study of Exciton Dynamics in a Simple Liquid—Sighart Fischer and Stuart A. Rice. 176, 409 (1968)

### 41.1 Electron Correlations; Plasma Effects (see also 35)

Effect of Nonparabolicity on Light Scattering from Plasmas in Solids—P. A. Wolff. 171, 436 (1968)

Plasma Frequency as a Test of Intervalley Transfer in the Gunn Effect—M. A. Omar. 171, 925 (1968)

Convergence of the Two-Component Plasma Correlation Function—Y. C. Lee, D. L. Lin, and Ta-You Wu. 172, 145 (1968)

Erratum: Kinetic Equation for Drifted Electron Plasma—N. Tzoar. [162, 123 (1967)] 172, 241 (1968)

Plasmons and Zeroth Sound in the Electron Gas—L. L. Van Zandt. 172, 372 (1968)

Exchange and the Dielectric Screening Function—Leonard Kleinman. 172, 383 (1968)

Radiative Decay of Coulomb-Stimulated Plasmons in Spheres—Julian Crowell and R. H. Ritchie. 172, 436 (1968)

Reflectance and $1/\epsilon$ Resonance of Beryllium in the Far Ultraviolet—J. Toots, H. A. Fowler, and L. Marton. 172, 670 (1968)

Fermi-Liquid Effects on Plasma Wave Propagation in Metals—S. C. Ying and J. J. Quinn. 173, 473 (1968)

Transmission Electron Spin Resonance in Dilute Copper-Chromium Alloys—P. Monod and S. Schultz. 173, 645 (1968)

Kinetic Equations for Turbulent Plasmas. I. Quasilinear Theory—Setsuo Ichimaru. 174, 289 (1968)

Kinetic Equations for Turbulent Plasmas. II. Fluctuation Spectrum—Setsuo Ichimaru. 174, 300 (1968)

Light Scattering from a Plasma in a Magnetic Field—P. M. Platzman, P. A. Wolff, and N. Tzoar. 174, 489 (1968)

Sum Rule for the Landau Fermi-Liquid Parameters in Metals—W. F. Brinkman, P. M. Platzman, and T. M. Rice. 174, 495 (1968)

Electromodulation of the Optical Properties of Gold—Wilford N. Hansen and Arnold Prostak. 174, 500 (1968)

Search for Plasmaron Structure in the Soft X-Ray $L_{2,3}$ Emission Spectrum of Al—J. R. Cuthill, R. C. Dobbyn, A. J. McAlister, and M. L. Williams. 174, 515 (1968)

Possible Cooperative Phase for Electrons in Double-Stranded DNA—E. W. Fenton. 174, 517 (1968)

Modification of Friedel Oscillations by a Magnetic Field—Marvin E. Rensink. 174, 744 (1968)
A Parametric Approach to the Ground-State Energy of an Electron Gas—M. S. Becker, A. A. Broyles, and Tucson Dunn. 175, 224 (1968)
Landau Fermi-Liquid Parameters in Na and K—T. M. Rice. 175, 858 (1968)
Dielectric Screening and the Phonon Spectra of Metallic and Nonmetallic Crystals—P. N. Keating. 175, 1171 (1968)
Circular One-Dimensional Model for the Electron-Ion System. I. Random-Phase Approximation—Gideon Carmi. 176, 510 (1968)
Circular One-Dimensional Model for the Electron-Ion System. II. First-Order Phase Transitions in the Random-Phase Approximation—Gideon Carmi. 176, 521 (1968)
Simple Microscopic Theory of Surface Plasmons—Peter J. Feibelman. 176, 551 (1968)
Electron Correlations at Metallic Densities—K. S. Singwi, M. P. Tosi, R. H. Land, and A. Sjölander. 176, 589 (1968)
Theory of the Tunneling Spectroscopy of Collective Excitations—Alan J. Bennett, C. B. Duke, and S. D. Silverstein. 176, 969 (1968)
Density Matrices in the Many-Body Problem—P. Gluck. 176, 1534 (1968)

## 41.2 Critical Phenomena (see also 32.4 and 41.4)

Structure of Correlation Functions near the Critical Point—Gerald L. Jones. 171, 243 (1968)
Combinatorial Approach to the Ferroelectric Problem—R. W. Gibberd. 171, 563 (1968)
Analytic Free Energy: A Basis for Scaling Laws—Michael H. Coppersmith. 172, 230 (1968)
Determination of Critical Behavior in Lattice Statistics from Series Expansions. I.—Anthony J. Guttmann, Barry W. Ninham, and Colin J. Thompson. 172, 554 (1968)
Homogeneity of the Correlation Length in the Critical Region—G. Stell. 173, 314 (1968)
Ultrasonic Attenuation near the Critical Point of $MnF_2$—J. R. Neighbours and R. W. Moss. 173, 542 (1968)
Anomalous Electrical Conductivity above the Superconducting Transition—Leo P. Kadanoff and George Laramore. 175, 579 (1968)
Ordering Energy and Effective Pairwise Interactions in a Binary Alloy of Simple Metals—Timothy M. Hayes, Harvey Brooks, and Arthur Bienenstock. 175, 699 (1968)
Neutron Measurement of Clustering in the Alloy CuNi—B. Mozer, D. T. Keating, and S. C. Moss. 175, 868 (1968)
Renormalization of Critical Exponents by Hidden Variables—Michael E. Fisher. 176, 257 (1968)
Some Remarks on Perturbation Theory and Critical Phenomena—P. T. Herman and J. R. Dorfman. 176, 295 (1968)
Crystalline Transformation of Helium Three—Louis Goldstein. 176, 311 (1968)
Theory of a Two-Dimensional Ising Model with Random Impurities. I. Thermodynamics—Barry M. McCoy and Tai Tsun Wu. 176, 631 (1968)
Phenomenology of Neutron Scattering in Heisenberg Systems—Herbert S. Bennett. 176, 650 (1968)
Spherical Model as the Limit of Infinite Spin Dimensionality—H. E. Stanley. 176, 718 (1968)
High-Temperature Critical Indices for the Classical Anisotropic Heisenberg Model—David Jasnow and Michael Wortis. 176, 739 (1968)
Critical Behavior of the Ising, $XY$, and Heisenberg Ferromagnets on the $B$-Site Spinel Lattice—David Jasnow and M. A. Moore. 176, 751 (1968)

## 41.3 Long-Range Magnetic Order (see also 49)

Non-Closed-Shell Linear Chain: The $H_{\pi}$ System—W. T. Kwo. 171, 484 (1968)
Surface Effects in the Heisenberg Antiferromagnet—D. L. Mills and W. M. Saslow. 171, 488 (1968)
Absence of Magnetic Ordering in One and Two Dimensions in a Many-Band Model for Interacting Electrons in a Metal—M. B. Walker and Th. W. Ruijgrok. 171, 513 (1968)
Application of the Cluster-Variation Method to the Uniaxial Antiferromagnet $FeF_2$—Tomoyasu Tanaka, Louis Libelo, and Ronald Kligman. 171, 531 (1968)
Further Investigation of Local Moments in Metals—M. Levine and H. Suhl. 171, 567 (1968)
Excitation Spectrum of Antiferromagnetic Rings—D. B. Abraham. 171, 572 (1968)
Short-Range Magnetic Order in a Modified Weiss Molecular-Field Theory—Robert L. Peterson. 171, 586 (1968)
Divergences in the Space-Time Correlation Functions for the Heisenberg Magnet in One Dimension—J. F. Fernandez and H. A. Gersch. 172, 341 (1968)
Collective Excitations and Magnetic Ordering in Materials with Singlet Crystal-Field Ground State—Yung-Li Wang and Bernard R. Cooper. 172, 539 (1968)
Temperature Dependence of the $^{57}Fe$ hfs in the Ordered Alloys $FePd_3$ and FePd near the Curie Temperature—G. Longworth. 172, 572 (1968)
Free Energy of the Classical Heisenberg Model—R. L. Stephenson and P. J. Wood. 173, 475 (1968)
Spin Correlation Functions of the $X$-$Y$ Model—Barry M. McCoy. 173, 531 (1968)
Estimate of Damping of Short-Wave Magnons for a Heisenberg Ferromagnet below $T_C$—P. D. Loly and S. Doniach. 173, 603 (1968)
Statistical-Mechanical Theory of Resonance Susceptibility in Heisenberg Antiferromagnetism—Jeremiah H. Barry. 174, 531 (1968)
Theory of Toeplitz Determinants and the Spin Correlations of the Two-Dimensional Ising Model. V—Barry M. McCoy and Tai Tsun Wu. 174, 546 (1968)
Magnetization Distribution in Magnetically Diluted Systems with Application to Iron-Palladium—T. A. Kitchens and W. L. Trousdale. 174, 606 (1968)
Bounds for the Isothermal, Adiabatic, and Isolated Static Susceptibility Tensors—R. M. Wilcox. 174, 624 (1968)
Diffuse and Propagating Modes in the Heisenberg Paramagnet—Herbert S. Bennett. 174, 629 (1968)
Dynamics of the Heisenberg Ferromagnet at Low Temperature—Richard Silberglitt and A. Brooks Harris. 174, 640 (1968)
Magnon Density Fluctuations in the Heisenberg Ferromagnet—George F. Reiter. 175, 631 (1968)
Calculation of the Sublattice Magnetization of Yttrium Iron Garnet by the Oguchi Method—Denis F. Strenzwilk and Elmer E. Anderson. 175, 654 (1968)
Energy Width of Spin Waves in the Heisenberg Ferromagnet—A. Brooks Harris. 175, 674 (1968)
Theory of a Two-Dimensional Ising Model with Random Impurities. I. Thermodynamics—Barry M. McCoy and Tai Tsun Wu. 176, 631 (1968)
Theory of Anisotropic Spontaneous Magnetization and Anisotropy Energy in Orthorhombic Ferromagnets at 0°K—George T. Rado. 176, 644 (1968)
Free Energy of Interacting Magnetic Dipoles—Robert B. Griffiths. 176, 655 (1968)
Linear Chain Antiferromagnetism in $CsMnCl_3 \cdot 2H_2O$—T. Smith and S. A. Friedberg. 176, 660 (1968)

Spherical Model as the Limit of Infinite Spin Dimensionality—H. E. Stanley. 176, 718 (1968)

High-Temperature Critical Indices for the Classical Anisotropic Heisenberg Model—David Jasnow and Michael Wortis. 176, 739 (1968)

Critical Behavior of the Ising, $XY$, and Heisenberg Ferromagnets on the $B$-Site Spinel Lattice—David Jasnow and M. A. Moore. 176, 751 (1968)

Erratum: Surface Effects in the Heisenberg Antiferromagnet—D. L. Mills and W. M. Saslow. [171, 488 (1968)] 176, 760 (1968)

## 41.4 Superconductivity—Theory (see also 31)

Ginzburg-Landau Theory of Surface Superconductivity and Magnetic Hysteresis—P. Voetmann Christiansen and Henrik Smith. 171, 445 (1968)

Temperature Dependence of the Flux-Flow Resistance near $H_{c2}$ in Type-II Superconductors—Carl J. Axt and W. C. H. Joiner. 171, 461 (1968)

Erratum: Ultrasonic Attenuation of Pure Strong-Coupling Superconductors—James W. F. Woo. [155, 429 (1967)] 171, 610 (1968)

Longitudinal Ultrasonic Attenuation in Pure Strong-Coupling Superconductors. II.—James W. F. Woo. 172, 423 (1968)

Intrinsic Resistive Transition in Thin Superconducting Wires Driven from Current Sources—D. E. McCumber. 172, 427 (1968)

Relation between Superconductivity and Lattice Instability in the $\beta$-W Compounds—J. Labbé. 172, 451 (1968)

High-Frequency Sound Absorption in Superconductors—Joel Alan Snow. 172, 455 (1968)

Theory of Superconductors with Overlapping Bands in the Presence of Nonmagnetic Impurities—W. S. Chow. 172, 467 (1968)

Superconductivity in Simple Metals—J. P. Carbotte and R. C. Dynes. 172, 476 (1968)

Antilinear Operators in Hartree-Bogolyubov Theory. I—Fedor Herbut and Milan Vujičić. 172, 1031 (1968)

Surface Impedance of Type-I Superconductors: Calculation of the Effect of a Static Magnetic Field—M. P. Garfunkel. 173, 516 (1968)

Nonlinear Effect in the Shear-Wave Attenuation near $T_c$ in Superconductors—K. Fossheim. 173, 526 (1968)

Erratum: Towards a Quantum Many-Body Theory of Lattice Dynamics. II. Collective Fluctuation Approximation—N. S. Gillis and N. R. Werthamer. [167, 607 (1968)] 173, 918 (1968)

Possibility of Photoinduced Superconductivity—N. Kumar and K. P. Sinha. 174, 482 (1968)

Possible Cooperative Phase for Electrons in Double-Stranded DNA—E. W. Fenton. 174, 517 (1968)

Tunneling Model of the Superconducting Proximity Effect—W. L. McMillan. 175, 537 (1968)

Calculation of the Effect of Superconducting Energy-Gap Anisotropy on the Thermal Conductivity of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 556 (1968)

Theory of Superconductor–Normal-Metal Interfaces—W. L. McMillan. 175, 559 (1968)

Anomalous Electrical Conductivity above the Superconducting Transition—Leo P. Kadanoff and George Laramore. 175, 579 (1968)

dc Josephson Effect for Strong-Coupling Superconductors—T. A. Fulton and D. E. McCumber. 175, 585 (1968)

Scattering of Single-Particle Excitations by a Vortex in a Clean Type-II Superconductor—Robert M. Cleary. 175, 587 (1968)

Microwave Properties of Granular Superconductors—Roger W. Cohen and J. I. Gittleman. 176, 500 (1968)

Circular One-Dimensional Model for the Electron-Ion System. I. Random-Phase Approximation—Gideon Carmi. 176, 510 (1968)

Circular One-Dimensional Model for the Electron-Ion System. II. First-Order Phase Transitions in the Random-Phase Approximation—Gideon Carmi. 176, 521 (1968)

Upper Critical Field of Two-Band Superconductors Containing Nonmagnetic Impurities—W. S. Chow. 176, 525 (1968)

Motion of Normal Regions Along a Superconducting Strip—John R. Clem. 176, 531 (1968)

Anomalous Thermal Conductivity of Superconductors due to Impurity Spin Ordering—K. H. Bennemann and F. M. Mueller. 176, 546 (1968)

Effect of Orbital Quantization on the Critical Field of Type-II Superconductors—L. W. Gruenberg and L. Gunther. 176, 606 (1968)

## 41.5 Superconductivity—Experiment

Complex Radio-Frequency Impedance of Type-II Superconductors—George E. Possin and Kenneth W. Shepard. 171, 458 (1968)

Temperature Dependence of the Flux-Flow Resistance near $H_{c2}$ in Type-II Superconductors—Carl J. Axt and W. C. H. Joiner. 171, 461 (1968)

Specific Heat of a Spherical Type-II Superconductor—Paul Zoller and J. R. Dillinger. 172, 390 (1968)

Excess Currents in Superconducting Tunnel Junctions—J. M. Rowell and W. L. Feldmann. 172, 393 (1968)

Low-Temperature Amplitude-Independent Longitudinal Ultrasonic Attenuation in Normal Lead—W. A. Fate. 172, 402 (1968)

Amplitude-Independent Longitudinal Ultrasonic Attenuation in Superconducting Lead—W. A. Fate, R. W. Shaw, and G. L. Salinger. 172, 413 (1968)

Superconducting Transition Temperatures of Lead-Thallium Alloys—Eckhard Nembach. 172, 425 (1968)

Critical-Field Curves for Gapless Superconductors—W. R. Decker and D. K. Finnemore. 172, 430 (1968)

The Mixed State in Superconducting Thin Films—F. E. Harper and M. Tinkham. 172, 441 (1968)

Hysteresis in Superconductors. III. Effect of Surface Energies on the Shielding and Field-Retaining Properties of Hollow Cylinders of Type-I Superconductors—Donald G. Schweitzer. 173, 461 (1968)

Magnetic Transitions of Superconducting Thin Films and Foils. I. Lead—G. D. Cody and R. E. Miller. 173, 481 (1968)

Magnetic Transitions of Superconducting Thin Films and Foils. II. Tin—R. E. Miller and G. D. Cody. 173, 494 (1968)

Effect of Temperature and of Substitutional Mo on the Magnetic Behavior of Superconducting Nb—R. A. French and J. Lowell. 173, 504 (1968)

Ultrasonic Attenuation in Superconducting Mercury and Mercury-Cadmium Single Crystals—C. P. Newcomb and R. W. Shaw. 173, 509 (1968)

Experimental Upper Limit on the Magnetic Monopole Moment of Electrons, Protons, and Neutrons, Utilizing a Superconducting Quantum Interferometer—Lorin L. Vant-Hull. 173, 1412 (1968)

Coupled Motion of Vortices in Superposed Superconducting Films—R. Deltour and M. Tinkham. 174, 478 (1968)

Ultrasonic Attenuation in the Superconducting State of High-Purity Thallium—H. J. Willard, Jr., R. W. Shaw, and G. L. Salinger. 175, 362 (1968)

Effect of Antimony, Indium, and Zinc Impurities on the Critical-Field Curve of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 543 (1968)

Anisotropy of the Residual Resistivity of Tin with Sb, In, Zn, and Cd Impurities, and the Ideal Resistivities and Deviations from Matthiessen's Rule at 77 and 273°K—F. V. Burckbuchler and C. A. Reynolds. 175, 550 (1968)

Experimental Test of the Theory of the Proximity Effect in Superconductors—A. E. Jacobs and D. M. Ginsberg. 175, 569 (1968)

Magnetic Flux Penetration in Type-II Superconductors. I—G. del Castillo and R. W. Fast. 175, 575 (1968)

Ultrasonic Investigation of the Isolated-Vortex State near $H_{c1}$ in Vanadium—A. C. E. Sinclair and J. R. Leibowitz. 175, 596 (1968)

Ultrasonic Determination of the Pressure Dependence of the Superconducting Energy Gap in Tin—A. G. Beattie, J. E. Schirber, and J. R. Neighbours. 175, 599 (1968)

Magnetic-Field Dependence of Radio-Frequency Flux Penetration in Type-II Superconductors—D. E. Carlson and W. L. McLean. 176, 538 (1968)

Superconductivity of α-Phase U-Mo Alloys at Zero and High Pressures—J. E. Gordon, W. E. Gardner, T. F. Smith, C. W. Chu, and M. B. Maple. 176, 556 (1968)

Precision Measurement of Anisotropy in the Upper Critical Field of Superconducting Niobium—D. E. Farrell, B. S. Chandrasekhar, and S. Huang. 176, 562 (1968)

Fluxoid Quantization and Field-Induced Depairing in a Hollow Superconducting Microcylinder—R. P. Groff and R. D. Parks. 176, 567 (1968)

High-Frequency Surface Impedance of Dirty Type-II Superconductors in the Surface-Sheath Regime—Gaston Fischer and Kazumi Maki. 176, 581 (1968)

## 42 CRYSTAL STRUCTURE AND LATTICE PROPERTIES (see also 4(6-9).2)

### 42.1 Structure and Symmetries; Diffraction

Effective-Spin Hamiltonian for "Non-Kramers" Doublets—K. A. Mueller. 171, 350 (1968)

Correlation Functions of Disordered Binary Alloys. II—Philip C. Clapp and S. C. Moss. 171, 754 (1968)

Correlation Functions of Disordered Binary Alloys. III—S. C. Moss and Philip C. Clapp. 171, 764 (1968)

Origin of the Crystal Field in $Ti^{3+}$-Substituted Alums—Gerald F. Dionne and John A. MacKinnon. 172, 325 (1968)

Stable Potential Minima and the Jahn-Teller Interaction—P. Wysling and K. A. Müller. 173, 327 (1968)

Effect of Pressure on the Polymorphism and Melting Points of the Thallous Halides—Carl W. F. T. Pistorius and J. B. Clark. 173, 692 (1968)

Raman Spectrum of $LaBr_3$—C. K. Asawa. 173, 869 (1968)

Mass Dependence of the Angular Distribution of Charged-Particle Emission from Crystals: Transition to the Classical Limit—R. E. De Wames, W. F. Hall, and G. W. Lehman. 174, 392 (1968)

Selection Rules for an Electronic Raman Effect in a Situation where the Appropriate Point Group is a Double Group—J. A. Koningstein. 174, 477 (1968)

Debye-Waller Factors in Rare-Gas Solids—Victor V. Goldman. 174, 1041 (1968)

Neutron Measurement of Clustering in the Alloy CuNi—B. Mozer, D. T. Keating, and S. C. Moss. 175, 868 (1968)

Intensity of Forbidden Neutron Reflections Simulated by Multiple Bragg Reflection—D. A. Kottwitz. 175, 1056 (1968)

Crystalline Order in Two Dimensions—N. D. Mermin. 176, 250 (1968)

Magnetic Scattering of Electrons from Crystals and Polarization of the Scattered Beam—Lawrence A. Vredevoe and Roger E. De Wames. 176, 684 (1968)

### 42.2 Surfaces, Interfaces, and Films; Growth (see also 26)

Surface Effects in the Heisenberg Antiferromagnet—D. L. Mills and W. M. Saslow. 171, 488 (1968)

Multiphonon Scattering of Low-Energy Electrons—Robert F. Barnes, Max G. Lagally, and Maurice B. Webb. 171, 627 (1968)

Helicon Waves, Surface-Mode Loss, and the Accurate Determination of the Hall Coefficients of Aluminum, Indium, Sodium, and Potassium—John M. Goodman. 171, 641 (1968)

Ionic, Covalent, and Metallic Surface States of a One-Dimensional Mathieu Potential with Arbitrary Termination—Jules D. Levine. 171, 701 (1968)

Three Geometrical Modifications of the Surface-Impedance Experiment in Low Magnetic Fields—R. E. Prange. 171, 737 (1968)

Stationary High-Field Domains in the Range of Negative Differential Conductivity in CdS Single Crystals—K. W. Böer and P. Voss. 171, 899 (1968)

Gravitationally Induced Electric Field near a Conductor, and Its Relation to the Surface-Stress Concept—Conyers Herring. 171, 1361 (1968)

Experiments with Tunnel Junctions Using Ferromagnetic Metals—J. E. Christopher, R. V. Coleman, Acar Isin, and R. C. Morris. 172, 485 (1968)

Calculation of the Anharmonic Damping of Rayleigh Surface Modes—A. A. Maradudin and D. L. Mills. 173, 881 (1968)

Statistical Mechanics of Monolayers of Bose and Fermi Atoms Adsorbed on Crystalline Surfaces—J. G. Dash and Michael Bretz. 174, 247 (1968)

Effects of Finite Boundaries on a One-Dimensional Harmonic Oscillator—Richard Vawter. 174, 749 (1968)

Effects of a Tilted Magnetic Field on a Two-Dimensional Electron Gas—F. F. Fang and P. J. Stiles. 174, 823 (1968)

Optical Properties of Epitaxial PbSe Films—C.-E. Blomqvist and P.-O. Nilsson. 174, 849 (1968)

Ionic Surface States from a Band-Edge Method—Jules D. Levine and S. G. Davison. 174, 911 (1968)

Erratum: Electron Tunneling in Metal-Semiconductor Barriers—J. W. Conley, C. B. Duke, G. D. Mahan, and J. J. Tiemann. [150, 466 (1966)] 174, 1082 (1968)

Metastable Atoms and Molecules. III. Metastable Impacts on Surfaces with Various Work Functions—R. N. Varney. 175, 98 (1968)

Theory of Superconductor–Normal-Metal Interfaces—W. L. McMillan. 175, 559 (1968)

Size Effect in Electrical Conductivity of Metallic Films with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey, J. R. Sybert, and W. D. Deering. 175, 729 (1968)

Kinetics of Oxide Film Growth on Metal Crystals: Electronic and Ionic Diffusion in Large Surface-Charge and Space-Charge Fields—A. T. Fromhold, Jr., and Earl L. Cook. 175, 877 (1968)

Electron-Phonon Coupling in the Barriers of GaAs Schottky Diodes—P. Thomas and H. J. Queisser. 175, 983 (1968)

Influence of Ellipsoidal Energy Surfaces on the Differential Resistance of Schottky Barriers—R. Stratton and F. A. Padovani. 175, 1072 (1968)

Microwave Properties of Granular Superconductors—Roger W. Cohen and J. I. Gittleman. 176, 500 (1968)

High-Frequency Surface Impedance of Dirty Type-II Superconductors in the Surface-Sheath Regime—Gaston Fischer and Kazumi Maki. 176, 581 (1968)

Specific Heat of Uranium Mononitride from 1.3 to 4.6°K—J. O. Scarbrough, H. L. Davis, W. Fulkerson, and J. O. Betterton, Jr. 176, 666 (1968)

Erratum: Surface Effects in the Heisenberg Antiferromagnet—D. L. Mills and W. M. Saslow. [171, 488 (1968)] 176, 760 (1968)

Size Effect in the Electrical Conductivity of Cylindrical Wires—H. J. Mackey, W. D. Deering, and J. R. Sybert. 176, 856 (1968)

Anomalous Size Effects in the Galvanomagnetic Properties of Zinc Caused by Compensation—Stephen B. Soffer. 176, 861 (1968)

Optical Properties of Free-Electron-Like Foils—R. J. Esposito, Philip E. Bloomfield, and L. Muldawer. 176, 886 (1968)

Electron and Phonon Tunneling Spectroscopy in Metal-Germanium Contacts—F. Steinrisser, L. C. Davis, and C. B. Duke. 176, 912 (1968)

Theory of the Tunneling Spectroscopy of Collective Excitations—Alan J. Bennett, C. B. Duke, and S. D. Silverstein. 176, 969 (1968)

Comments and Addenda: Influence of Band Structure on the Nonlocal Conductivity of Metals and the Anomalous Skin Effect—M. L. Glasser. 176, 1110 (1968)

## 42.3 Lattice Dynamics (see also 45)

"Boltzmann Statistics" without Statistics in the Classical Harmonic Lattice—Leon Gunther. 171, 210 (1968)

Effective-Spin Hamiltonian for "Non-Kramers" Doublets—K. A. Mueller. 171, 350 (1968)

Multiphonon Scattering of Low-Energy Electrons—Robert F. Barnes, Max G. Lagally, and Maurice B. Webb. 171, 627 (1968)

Theory of Localized Vibrations of Interstitial Atoms in bcc Lattices—G. Blaesser, J. Peretti, and G. Toth. 171, 665 (1968)

Self-Consistent-Field Approximations in Disordered Alloys—P. L. Leath. 171, 725 (1968)

Lattice Dynamics of Niobium-Molybdenum Alloys—B. M. Powell, P. Martel, and A. D. B. Woods. 171, 727 (1968)

Examination of the Thermal Variation of the Mean Square Atomic Displacements in Zinc and Evaluation of the Associated Debye Temperature—Earl F. Skelton and J. Lawrence Katz. 171, 801 (1968)

Theory of Parametric Gain near a Lattice Resonance—C. H. Henry and C. G. B. Garrett. 171, 1058 (1968)

Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)

Low-Temperature Amplitude-Independent Longitudinal Ultrasonic Attenuation in Normal Lead—W. A. Fate. 172, 402

A Quantum Dissipation Theory of Anharmonic Crystals—A. H. Opie. 172, 640 (1968)

Effect of Uniaxial and Hydrostatic Strain on the Optical Constants and the Electronic Structure of Copper—Ulrich Gerhardt. 172, 651 (1968)

Theory of the Vibrations of Dilute Alloys with Short-Range Order—W. M. Hartmann. 172, 677 (1968)

Application of a Modified Random-Element-Isodisplacement Model to Long-Wavelength Optic Phonons of Mixed Crystals—I. F. Chang and S. S. Mitra. 172, 924 (1968)

Thermal-Expansion Measurements and Thermodynamics of Solid Krypton—D. L. Losee and R. O. Simmons. 172, 944 (1968)

Erratum: Second-Harmonic Generation of Microwave Phonons in Quartz and Sapphire—Paul H. Carr. [169, 719 (1968)] 173, 325 (1968)

Effects Seen in the Passage of Positively Charged Ions through Single Crystals—R. E. Holland and D. S. Gemmell. 173, 344 (1968)

Lattice-Dynamical Properties of $Fe^{57}$ Impurity Atoms in Pt, Pd, and Cu from Precision Measurements of Mössbauer Fractions—Rudi H. Nussbaum, Donald G. Howard, Wilbur L. Nees, and Charles F. Steen. 173, 653 (1968)

Phonon Dispersion Curves by Raman Scattering in SiC, Polytypes 3*C*, 4*H*, 6*H*, 15*R*, and 21*R*—D. W. Feldman, James H. Parker, Jr., W. J. Choyke, and Lyle Patrick. 173, 787 (1968)

Symmetry and Reststrahlen in Elemental Crystals—Richard Zallen. 173, 824 (1968)

Optical Phonons and Dynamic Charge in Trigonal Se and Te—Inan Chen and Richard Zallen. 173, 833 (1968)

Optical Phonons of Yttrium Aluminum Garnet—J. P. Hurrell, S. P. S. Porto, I. F. Chang, S. S. Mitra, and R. P. Bauman. 173, 851 (1968)

Some Features of the Temperature Dependence of Infrared Absorption by Localized Vibrational Modes—A. E. Hughes. 173, 860 (1968)

Isotope Effects in the Lattice Constant and Thermal Expansion of $^{20}Ne$ and $^{22}Ne$ Single Crystals—D. N. Batchelder, D. L. Losee, and R. O. Simmons. 173, 873 (1968)

Calculation of the Anharmonic Damping of Rayleigh Surface Modes—A. A. Maradudin and D. L. Mills. 173, 881 (1968)

Erratum: Towards a Quantum Many-Body Theory of Lattice Dynamics. II. Collective Fluctuation Approximation—N. S. Gillis and N. R. Werthamer. [167, 607 (1968)] 173, 918 (1968)

Phonon Spectrum of hcp $He^4$—V. J. Minkiewicz, T. A. Kitchens, F. P. Lipschultz, R. Nathans, and G. Shirane. 174, 267 (1968)

Raman Spectrum of Single-Domain $BaTiO_3$—M. DiDomenico, Jr., S. H. Wemple, S. P. S. Porto, and R. P. Bauman. 174, 522 (1968)

Angular Forces in the Lattice Dynamics of Face-Centered Cubic Metals. II—Y. P. Varshni and P. S. Yuen. 174, 766 (1968)

Neutron Scattering from MgO—G. M. Borgonovi and G. W. Carriveau. 174, 953 (1968)

Pressure Dependence of Infrared Eigenfrequencies of KCl and KBr—C. Postmus, J. R. Ferraro, and S. S. Mitra. 174, 983 (1968)

Far-Infrared Properties of Lattice Resonant Modes. II. Stress Effects—I. G. Nolt and A. J. Sievers. 174, 1004 (1968)

Vibronic Transitions of $Sm^{2+}$ and $Eu^{2+}$ in $SrF_2$ and their Zeeman Effect—E. Cohen and H. J. Guggenheim. 175, 354 (1968)

Effective Density of Phonon States for $NdCl_3$ from Vibronic Spectra and Applications to Ion-Lattice Interactions—E. Cohen, L. A. Riseberg, and H. W. Moos. 175, 521 (1968)

Second- and Third-Order Elastic Constants of Alkali Metals—Tetsuro Suzuki, A. V. Granato, and J. F. Thomas, Jr. 175, 766 (1968)

Correlation between Mössbauer Resonance Strength and Second-Order Doppler Shift: Estimate of Zero-Point Velocity—R. Dean Taylor and Paul P. Craig. 175, 782 (1968)

Effect of Force-Constant Changes on the Incoherent Neutron Scattering from Cubic Crystals with Point Defects—Katja Lakatos and J. A. Krumhansl. 175, 841 (1968)

Displacement Correlations and Frequency Spectra for Mass-Disordered Lattices. II—Paul L. Leath and Bernard Goodman. 175, 963 (1968)

Phonons in Time-Dependent Hartree Approximation with Application to Order-Disorder Ferroelectrics—P. B. Miller and P. C. Kwok. 175, 1062 (1968)

Ultrasonic Attenuation in Dirty Dielectric Crystals—H. J. Maris. 175, 1077 (1968)

Lattice Dynamics and Ionic Deformation in Some Alkali Halides—J. S. Melvin, J. D. Pirie, and T. Smith. 175, 1082 (1968)

Calculation of the Self-Consistent Phonon Spectrum of hcp He —N. S. Gillis, T. R. Koehler, and N. R. Werthamer. 175, 1110 (1968)

Accurate Numerical Method for Calculating Frequency Distribution Functions in Solids. III. Extension to Tetragonal Crystals—Z. Kam and G. Gilat. 175, 1156 (1968)

Dielectric Screening and the Phonon Spectra of Metallic and Nonmetallic Crystals—P. N. Keating. 175, 1171 (1968)

Long-Wavelength Optical Lattice Vibrations in Mixed $KMgF_3$-$KNiF_3$ Crystals—A. S. Barker, Jr., J. A. Ditzenberger, and H. J. Guggenheim. 175, 1180 (1968)

Dynamics of Disordered Harmonic Lattices. III. Normal-Mode Spectra for Abnormal Arrays—Daniel N. Payton, III, and William M. Visscher. 175, 1201 (1968)

Theoretical Study on the Anisotropy of the Spin-Lattice Relaxation for Paramagnetic Ions by MgO Crystal—Santosh Kumar, T. Ray, and D. K. Ray. 176, 489 (1968)

Inelastic Scattering of Neutrons by Polycrystals—F. W. de Wette and Aneesur Rahman. 176, 784 (1968)

Vibrations of Disordered Solids—Herbert B. Rosenstock and Richard E. McGill. 176, 1004 (1968)

Lattice Thermal Conductivity for a One-Dimensional, Harmonic, Isotopically Disordered Crystal—Kenneth R. Allen and Joseph Ford. 176, 1046 (1968)

Effect of Many-Body van der Waals Forces on the Lattice Dynamics of Rare-Gas Crystals—A. A. Lucas. 176, 1093 (1968)

Raman Scattering in $KNO_3$ Phases I, II, and III—M. Balkanski, M. K. Teng, and M. Nusimovici. 176, 1098 (1968)

### 42.4 Static Thermal and Mechanical Properties (see also 33)

Shock Compression of Argon and Xenon. IV. Conversion of Xenon to a Metal-Like State—Marvin Ross. 171, 777 (1968)

Examination of the Thermal Variation of the Mean Square Atomic Displacements in Zinc and Evaluation of the Associated Debye Temperature—Earl F. Skelton and J. Lawrence Katz. 171, 801 (1968)

Study of an Impurity Mode Using Specific-Heat Measurements—J. P. Harrison, P. P. Peressini, and R. O. Pohl. 171, 1037 (1968)

Shape-Dependent Thermodynamic Quantities in Magnetic Systems with Dipole Interaction—Heinz Horner. 172, 535 (1968)

Pressure Dependence of the Elastic Constants of Calcite—Dattatraya P. Dandekar. 172, 873 (1968)

Ground State of Solid Neon—Jean-Pierre Hansen. 172, 919 (1968)

Thermal-Expansion Measurements and Thermodynamics of Solid Krypton—D. L. Losee and R. O. Simmons. 172, 944 (1968)

Pressure Derivatives of Second-Order Elastic Constants of MgO—S. Y. La and G. R. Barsch. 172, 957 (1968)

Heat Capacity of $\alpha$-Manganese from 0.2 to 0.4°K—B. D. Martin and C. V. Heer. 173, 631 (1968)

Steady-State, ac-Temperature Calorimetry—Paul F. Sullivan and G. Seidel. 173, 679 (1968)

Isotope Effects in the Lattice Constant and Thermal Expansion of $^{20}Ne$ and $^{22}Ne$ Single Crystals—D. N. Batchelder, D. L. Losee, and R. O. Simmons. 173, 873 (1968)

Angular Forces in the Lattice Dynamics of Face-Centered Cubic Metals. II—Y. P. Varshni and P. S. Yuen. 174, 766 (1968)

Specific Heats of Cu, GaAs, GaSb, InAs, and InSb from 1 to 30°K—T. C. Cetas, C. R. Tilford, and C. A. Swenson. 174, 835 (1968)

Measurement of Higher-Order Elastic Constants, Using Finite Deformations—B. E. Powell and M. J. Skove. 174, 977 (1968)

Simplified Theory of Anharmonic Contributions to the Thermodynamic Properties of Solid Sodium Metal—D. John Pastine. 175, 905 (1968)

Third-Order Elastic Constants of Aluminum—J. F. Thomas, Jr. 175, 955 (1968)

Qualitative Temperature and Volume Dependence of the Thermal Expansion Coefficient of Solids—Duane C. Wallace. 176, 827 (1968)

Pseudopotential Calculation of the Thermal Expansion Coefficient of Sodium and Potassium—Duane C. Wallace. 176, 832 (1968)

## 43 IMPERFECTIONS AND IMPURITIES; ALLOYS (see also 4(6-9).3)

Further Investigation of Local Moments in Metals—M. Levine and H. Suhl. 171, 567 (1968)

### 43.1 Defects and Dislocations (see also 48.7)

Calculation of the Deformation Energy of a Schottky Defect in Germanium—C. J. Hwang and L. A. K. Watt. 171, 958 (1968)

Limitation of the Phonon Heat Conductivity by Edge-Dislocation Dipoles, Single Dislocations, and Normal Processes —Peter Gruner and Helmut Bross. 172, 583 (1968)

Steady-State Photoconductivity in the Presence of Traps—O. L. Curtis, Jr. 172, 773 (1968)

Equilibrium Vacancy Concentration Measurements on Solid Krypton—D. L. Losee and R. O. Simmons. 172, 934 (1968)

Comparison of Defects Injected into Platinum by Quenching and by Radiation Doping—J. J. Jackson and K. Herschbach. 173, 664 (1968)

Electronic Energy States of Dislocations in CdS-Type Semiconductors—R. R. Holmes and C. Elbaum. 173, 803 (1968)

Energy and Orientation Dependence of Electron-Irradiation-Induced Damage in Undoped GaSb—K. Thommen. 174, 938 (1968)

Application of the Method of Lattice Statics to Interstitial Cu Atoms in Cu—John W. Flocken and John R. Hardy. 175, 919 (1968)

Electromigration in Zinc Single Crystals—J. L. Routbort, 176, 796 (1968)

Stage-III Annealing in Gold after Electron Irradiation—C. Lee and J. S. Koehler. 176, 813 (1968)

Determination of the Number of Unique Configurations of Unrelaxed Clusters in Crystal Lattices—A. P. Brody and M. Meshii. 176, 845 (1968)

Hypersonic Attenuation in Rutile—James N. Lange. 176, 1030 (1968)

Paraelectric-Resonance Spectroscopy—T. L. Estle. 176, 1056 (1968)

## 43.2 Radiation Damage (see also 27)

Characteristics of Neutron Damage in Silicon—L. J. Cheng and J. Lori. 171, 856 (1968)

Energy Dependence of Damage Recovery in *n*-Type Ge Electron-Irradiated at 4.2°K—Rudolf E. Penczer and Henry M. DeAngelis. 171, 862 (1968)

Steady-State Photoconductivity in the Presence of Traps—O. L. Curtis, Jr. 172, 773 (1968)

Optical and Electron-Spin-Resonance Studies of the $ICl^-$ $V_K$ Center in KCl:I—Lawrence S. Goldberg and Marvin L. Meistrich. 172, 877 (1968)

Partition of the Average Energy Deposited in Germanium as a Function of Incident Neutron Energy—Allan R. Sattler and Frederick L. Vook. 173, 435 (1968)

Comparison of Defects Injected into Platinum by Quenching and by Radiation Doping—J. J. Jackson and K. Herschbach. 173, 664 (1968)

Photoconductivity Studies of Defects in Silicon: Divacancy-Associated Energy Levels—A. H. Kalma and J. C. Corelli. 173, 734 (1968)

Erratum: Subthreshold Electron Damage in *n*-Type Germanium—Y. Chen and J. W. MacKay. [167, 745 (1968)] 173, 918 (1968)

Recovery of Resistivity of Pure and Alloyed Aluminum in Stages II and III after 2-MeV Electron Irradiation—P. B. Peters and P. E. Shearin. 174, 691 (1968)

Defects in Irradiated Silicon: Electron Paramagnetic Resonance and Electron-Nuclear Double Resonance of the Arsenic- and Antimony-Vacancy Pairs—Edward L. Elkin and G. D. Watkins. 174, 881 (1968)

Energy and Orientation Dependence of Electron-Irradiation-Induced Damage in Undoped GaSb—K. Thommen. 174, 938 (1968)

Color Centers in $MgF_2$—W. A. Sibley and O. E. Facey. 174, 1076 (1968)

Stored-Energy Release in Electron-Irradiated Germanium—M. P. Singh and J. W. MacKay. 175, 985 (1968)

Recombination Luminescence in Irradiated Silicon—Robert J. Spry and W. Dale Compton. 175, 1010 (1968)

Effect of Ion Bombardment on the Electrical Conductivity of Germanium—William Primak and Yogeshwar Dayal. 175, 1033 (1968)

Paramagnetic $NH_3Cl$ and $NH_3Br$ Color Centers in Irradiated Ammonium Halide Single Crystals—Frank W. Patten. 175, 1216 (1968)

Stage-III Annealing in Gold after Electron Irradiation—C. Lee and J. S. Koehler. 176, 813 (1968)

High-Temperature Recovery of Tungsten after Neutron Irradiation—L. K. Keys, J. P. Smith, and J. Moteff. 176, 851 (1968)

ESR Studies of Radiation-Damage Centers in Barium Sulfide—James L. Kolopus and Gerald J. Lapeyre. 176, 1025 (1968)

Recombination Luminescence from Self-Trapped Excitons in Ammonium Halide Crystals—M. J. Marrone and M. N. Kabler. 176, 1070 (1968)

Effect of Optical and Thermal Bleaching on the uv Bands in Highly Pure and Mn-Doped KCl Crystals—P. C. Mehendru and Ved Mitra. 176, 1089 (1968)

## 43.3 Impurities (see also 43.5)

Theory of Localized Vibrations of Interstitial Atoms in bcc Lattices—G. Blaesser, J. Peretti, and G. Toth. 171, 665 (1968)

Band Gap of Gallium Phosphide from 0 to 900°K and Light Emission from Diodes at High Temperatures—M. R. Lorenz, G. D. Pettit, and R. C. Taylor. 171, 876 (1968)

Photoelectronic Properties of ZnSe Crystals—Gerald B. Stringfellow and Richard H. Bube. 171, 903 (1968)

Study of an Impurity Mode Using Specific-Heat Measurements—J. P. Harrison, P. P. Peressini, and R. O. Pohl. 171, 1037 (1968)

Temperature-Dependent Internal Field Distribution and Magnetic Susceptibility of a Dilute Ising Spin System—Michael W. Klein. 173, 552 (1968)

Kondo Problem at Low Temperatures—S. Doniach. 173, 599 (1968)

Lattice-Dynamical Properties of $Fe^{57}$ Impurity Atoms in Pt, Pd, and Cu from Precision Measurements of Mössbauer Fractions—Rudi H. Nussbaum, Donald G. Howard, Wilbur L. Nees, and Charles F. Steen. 173, 653 (1968)

Concentration Quenching of Luminescence by Donors or Acceptors in Gallium Phosphide and the Impurity-Band Auger Model—J. C. Tsang, P. J. Dean, and P. T. Landsberg. 173, 814 (1968)

Magnetoresistance of Dilute Alloys—H. Rohrer. 174, 583 (1968)

Electronic Spin Polarization around a Magnetic Impurity Using Perturbation Theory—H. U. Everts and B. N. Ganguly. 174, 594 (1968)

Magnetization Distribution in Magnetically Diluted Systems with Application to Iron-Palladium—T. A. Kitchens and W. L. Trousdale. 174, 606 (1968)

Recovery of Resistivity of Pure and Alloyed Aluminum in Stages II and III after 2-MeV Electron Irradiation—P. B. Peters and P. E. Shearin. 174, 691 (1968)

Modification of Friedel Oscillations by a Magnetic Field—Marvin E. Rensink. 174, 744 (1968)

Decay Modes with Coherent Resonant-Energy Transfer between Deep Impurities in Solids—R. C. Casella. 174, 830 (1968)

Far-Infrared Properties of Lattice Resonant Modes. II. Stress Effects—I. G. Nolt and A. J. Sievers. 174, 1004 (1968)

Effect of Antimony, Indium, and Zinc Impurities on the Critical-Field Curve of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 543 (1968)

Anisotropy of the Residual Resistivity of Tin with Sb, In, Zn, and Cd Impurities, and the Ideal Resistivities and Deviations from Matthiessen's Rule at 77 and 273°K—F. V. Burckbuchler and C. A. Reynolds. 175, 550 (1968)

Application of the Cluster Variation Method to the *s-d* Interaction Hamiltonian—James Halow, Tomoyasu Tanaka, and Tohru Morita. 175, 680 (1968)

Dynamic Susceptibility of Magnetic Ions in Metals—Yung-Li Wang and D. J. Scalapino. 175, 734 (1968)

Effect of Force-Constant Changes on the Incoherent Neutron Scattering from Cubic Crystals with Point Defects—Katja Lakatos and J. A. Krumhansl. 175, 841 (1968)

Displacement Correlations and Frequency Spectra for Mass-Disordered Lattices. II—Paul L. Leath and Bernard Goodman. 175, 963 (1968)

Toward a Theory of Isoelectronic Impurities in Semiconductors—Roger A. Faulkner. 175, 991 (1968)

Theory of Impurity-Induced Infrared Absorption—Robert S. Wilson, W. T. King, and Shoon K. Kim. 175, 1164 (1968)

Coulomb Interactions in an Atomic Dielectric—G. D. Mahan and R. M. Mazo. 175, 1191 (1968)

Modified Orbach Relaxation Process in a $La(Cl, Br)_3$ Matrix—B. A. Young and H. J. Stapleton. 176, 502 (1968)

Upper Critical Field of Two-Band Superconductors Containing Nonmagnetic Impurities—W. S. Chow. 176, 525 (1968)

Ground-State Energy of the Anderson Model by the Cluster Variation Method—Shyamalendu M. Bose and Tomoyasu Tanaka. 176, 600 (1968)

Neutron Diffraction and Susceptibility Study of Dilute La–Rare-Earth Alloys—D. K. Finnemore, L. J. Williams, F. H. Spedding, and D. C. Hopkins. 176, 712 (1968)

Determination of the Number of Unique Configurations of Unrelaxed Clusters in Crystal Lattices—A. P. Brody and M. Meshii. 176, 845 (1968)

Phonon-Assisted Impurity Scattering in Gold Alloys—D. H. Damon, M. P. Mathur, and P. G. Klemens. 176, 876 (1968)

Calculation of Ionized-Impurity Scattering Mobility of Electrons in $Hg_{1-x}Cd_xTe$—Donald Long. 176, 923 (1968)

Electron-Capture ("Internal") Luminescence from the Oxygen Donor in Gallium Phosphide—P. J. Dean and C. H. Henry. 176, 928 (1968)

Donor-Acceptor Pair Recombination Involving the First Excited State of a Donor in GaAs—Jagdeep Shah, R. C. C. Leite, and J. P. Gordon. 176, 938 (1968)

Isoelectronic Oxygen Trap in ZnTe—J. L. Merz. 176, 961 (1968)

Vibrations of Disordered Solids—Herbert B. Rosenstock and Richard E. McGill. 176, 1004 (1968)

Lattice Thermal Conductivity for a One-Dimensional, Harmonic, Isotopically Disordered Crystal—Kenneth R. Allen and Joseph Ford. 176, 1046 (1968)

## 43.4 Atomic Diffusion and Mobility (see also 33.5)

Atomic Migration in Monatomic Crystals—C. P. Flynn. 171, 682 (1968)

Structure-Factor Approach to Migration Energy of Interstitials—Michael D. Feit and H. B. Huntington. 172, 580 (1968)

Equilibrium Vacancy Concentration Measurements on Solid Krypton—D. L. Losee and R. O. Simmons. 172, 934 (1968)

Optical, Electrical, and EPR Studies of KBr Crystals Doped with Cadmium—S. C. Jain and S. Radhakrishna. 172, 972 (1968)

Kinetic Study of Vacancy Clustering and Annealing in Metals—R. A. Johnson. 174, 684 (1968)

Direct Observation of Solid-State Diffusion Using the Mössbauer Effect—Robert C. Knauer and James G. Mullen. 174, 711 (1968)

Isotope Effect for Diffusion of Iron in Vanadium—M. G. Coleman, C. A. Wert, and R. F. Peart. 175, 788 (1968)

Kinetics of Oxide Film Growth on Metal Crystals: Electronic and Ionic Diffusion in Large Surface-Charge and Space-Charge Fields—A. T. Fromhold, Jr., and Earl L. Cook. 175, 877 (1968)

Defects in Rutile. II. Diffusion of Interstitial Ions—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1099 (1968)

Electronic Component of Dislocation Drag in Metals—G. P. Huffman and N. Louat. 176, 773 (1968)

Electromigration in Zinc Single Crystals—J. L. Routbort, 176, 796 (1968)

High-Temperature Recovery of Tungsten after Neutron Irradiation—L. K. Keys, J. P. Smith, and J. Moteff. 176, 851 (1968)

Ionic Transport in Potassium Chloride—Robert G. Fuller, Charles L. Marquardt, Michael H. Reilly, and John C. Wells, Jr. 176, 1036 (1968)

ac Dielectric Investigations of the Gyulai-Hartly Effect: Enhanced Conductivity in Alkali Halides following Plastic Deformation—M. C. Shine and R. K. MacCrone. 176, 1076 (1968)

Self-Diffusion in Solid Argon—E. H. C. Parker, H. R. Glyde, and B. L. Smith. 176, 1107 (1968)

## 43.5 Alloys (see also 43.3)

Nuclear Magnetic Resonance in Dilute Alloys of Indium-Lead and Indium-Tin—W. T. Anderson, Jr., F. C. Thatcher, and R. R. Hewitt. 171, 541 (1968)

Self-Consistent-Field Approximations in Disordered Alloys—P. L. Leath. 171, 725 (1968)

Lattice Dynamics of Niobium-Molybdenum Alloys—B. M. Powell, P. Martel, and A. D. B. Woods. 171, 727 (1968)

Correlation Functions of Disordered Binary Alloys. II—Philip C. Clapp and S. C. Moss. 171, 754 (1968)

Correlation Functions of Disordered Binary Alloys. III—S. C. Moss and Philip C. Clapp. 171, 764 (1968)

Optical Properties of Dilute Ag-In Alloys—R. M. Morgan and D. W. Lynch. 172, 628 (1968)

Theory of the Vibrations of Dilute Alloys with Short-Range Order—W. M. Hartmann. 172, 677 (1968)

Lattice Heat Conductivity in Annealed and Quenched Gold-Platinum Alloys—C. van Baarle and R. P. Huebener. 172, 699 (1968)

Erratum: Electrical Resistivity and Thermoelectric Power of CuAu Alloy—K. Teramoto and M. Tachiki. [166, 656 (1968)] 172, 1002 (1968)

Temperature-Dependent Internal Field Distribution and Magnetic Susceptibility of a Dilute Ising Spin System—Michael W. Klein. 173, 552 (1968)

Nuclear-Magnetic-Resonance Studies of $Mn^{55}$ in Ni–Mn Alloys—R. L. Streever. 173, 591 (1968)

Temperature-Dependent Isomer Shift and Anharmonic Binding of $Sn^{119}$ in $Nb_3Sn$ from Mössbauer-Effect Measurements—J. S. Shier and R. D. Taylor. 174, 346 (1968)

Magnetic Structure Properties of Alloys of Tb, Ho, and Er with Sc—H. R. Child and W. C. Koehler. 174, 562 (1968)

Pseudopotentials in Alloys and the Calculation of the Residual Resistivity—O. P. Gupta. 174, 668 (1968)

Erratum: Specific Heats below 3°K of Pure Copper, Silver, and Gold and of Extremely Dilute Gold-Transition-Metal Alloys—Douglas L. Martin. [170, 650 (1968)] 174, 1082 (1968)

Ordering Energy and Effective Pairwise Interactions in a Binary Alloy of Simple Metals—Timothy M. Hayes, Harvey Brooks, and Arthur Bienenstock. 175, 699 (1968)

Electronic Structure of One-Dimensional Binary Alloys—B. Y. Tong. 175, 710 (1968)

Single-Site Approximations in the Electronic Theory of Simple Binary Alloys—B. Velický, S. Kirkpatrick, and H. Ehrenreich. 175, 747 (1968)

Displacement Correlations and Frequency Spectra for Mass-Disordered Lattices. II—Paul L. Leath and Bernard Goodman. 175, 963 (1968)

High-Frequency Surface Impedance of Dirty Type-II Superconductors in the Surface-Sheath Regime—Gaston Fischer and Kazumi Maki. 176, 581 (1968)

Specific Heat below 3°K of Silver-Gold Alloys—Douglas L. Martin. 176, 790 (1968)

Band Model for Bismuth-Antimony Alloys—Stuart Golin. 176, 830 (1968)

Vibrations of Disordered Solids—Herbert B. Rosenstock and Richard E. McGill. 176, 1004 (1968)

## 44 ELECTRONIC STRUCTURE AND PROPERTIES (see also 4(6-9).4)

### 44.1 Electron States; Band Structure (see also 45)

Exchange Potential for Electrons in Atoms and Solids—David A. Liberman. 171, 1 (1968)

Effect of Nonparabolicity on Light Scattering from Plasmas in Solids—P. A. Wolff. 171, 436 (1968)

Spin-Orbit-Coupling Effects in Transition-Metal Compounds—John B. Goodenough. 171, 466 (1968)

Absence of Magnetic Ordering in One and Two Dimensions in a Many-Band Model for Interacting Electrons in a Metal—M. B. Walker and Th. W. Ruijgrok. 171, 513 (1968)

Ionic, Covalent, and Metallic Surface States of a One-Dimensional Mathieu Potential with Arbitrary Termination—Jules D. Levine. 171, 701 (1968)

Magnetoresistance of Potassium—John R. Reitz and A. W. Overhauser. 171, 749 (1968)

Self-Consistent Energy Bands of Metallic Copper by the Augmented-Plane-Wave Method. II.—E. C. Snow. 171, 785 (1968)

X-Ray Determination of Electron Momenta in Li, Be, B, Na, Mg, Al, and LiF—Walter C. Phillips and R. J. Weiss. 171, 790 (1968)

High-Resolution Study of the One-Electron Spectrum of Si—Luis R. Saravia and David Brust. 171, 916 (1968)

Plasma Frequency as a Test of Intervalley Transfer in the Gunn Effect—M. A. Omar. 171, 925 (1968)

Theory of Multiphoton Magnetoabsorption in Semiconductors—Margaret H. Weiler, M. Reine, and Benjamin Lax. 171, 949 (1968)

Erratum: Investigation of Energy-Band Structures and Electronic Properties of PbS and PbSe—Sohrab Rabii. [167, 801 (1968)] 171, 1114 (1968)

Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)

Symmetry of the Wave Functions in the Band Theory of Ferromagnetic Metals—L. M. Falicov and J. Ruvalds. 172, 498 (1968)

Fermi-Liquid Effects on High-Frequency Wave Propagation in Simple Metals—P. M. Platzman, W. M. Walsh, Jr., and E-Ni Foo. 172, 689 (1968)

Self-Consistent Energy Bands of Silver by an Augmented-Plane-Wave Method—E. C. Snow. 172, 708 (1968)

Screening and Electron Correlation Effects on the Electron-Phonon Interaction in Monovalent Metal—Hiroshi Takahashi. 172, 747 (1968)

Optical and Electrical Properties and Band Structure of GeTe and SnTe—R. Tsu, W. E. Howard, and L. Esaki. 172, 779 (1968)

Mechanism for the Photoreflectance Effect—J. G. Gay and L. T. Klauder, Jr. 172, 811 (1968)

Piezo-Electroreflectance in Ge, GaAs, and Si—Fred H. Pollak and Manuel Cardona. 172, 816 (1968)

Upper and Lower Bounds for the Intermediate-Coupling Polaron Ground-State Energy—David M. Larsen. 172, 967 (1968)

Optical Absorption and Energy Loss in Sodium in the Hartree Approximation—E-Ni Foo and J. J. Hopfield. 173, 635 (1968)

Electro-Optic Measurements of PbS, PbSe, and PbTe—D. E. Aspnes and M. Cardona. 173, 714 (1968)

Magnetic Energy Levels in an Energy Band with Inversion Asymmetry Splitting—Laura M. Roth. 173, 755 (1968)

Erratum: Investigation of Energy-Band Structures and Electronic Properties of PbS and PbSe—Sohrab Rabii. [167, 801 (1968)] 173, 918 (1968)

Search for Plasmaron Structure in the Soft X-Ray $L_{2,3}$ Emission Spectrum of Al—J. R. Cuthill, R. C. Dobbyn, A. J. McAlister, and M. L. Williams. 174, 515 (1968)

New Foundation for the Use of Pseudopotentials in Metals—William A. Goddard, III. 174, 659 (1968)

Form Factors of Truncated Atomic Potentials—J. C. Phillips and R. Sandrock. 174, 663 (1968)

Optimum Form of a Modified Heine-Abarenkov Model Potential for the Theory of Simple Metals—Robert W. Shaw, Jr. 174, 769 (1968)

New Evidence for the Existence of Exciton Effects at Hyperbolic Critical Points—Kerry L. Shaklee, J. E. Rowe, and Manuel Cardona. 174, 828 (1968)

Spectral Analysis of Photoemissive Yields in GaAs and Related Crystals—Frank Herman and W. E. Spicer. 174, 906 (1968)

Ionic Surface States from a Band-Edge Method—Jules D. Levine and S. G. Davison. 174, 911 (1968)

Electronic States of the *F* Center in Alkali Halide Crystals—W. Beall Fowler. 174, 988 (1968)

Intermediate-Coupling Polaron Effective Mass—David M. Larsen. 174, 1046 (1968)

Electronic Structure of One-Dimensional Binary Alloys—B. Y. Tong. 175, 710 (1968)

Photoemission Study of the Electronic Structure of ZnTe—J. L. Shay and W. E. Spicer. 175, 741 (1968)

Single-Site Approximations in the Electronic Theory of Simple Binary Alloys—B. Velický, S. Kirkpatrick, and H. Ehrenreich. 175, 747 (1968)

Band Structure and Electronic Properties of Silver—P. E. Lewis and P. M. Lee. 175, 795 (1968)

Critical-Point Structure in Photoelectric Emission Energy Distributions—Evan O. Kane. 175, 1039 (1968)

Application of the Orthogonalized-Plane-Wave Method to Lithium Chloride, Sodium Chloride, and Potassium Chloride—A. Barry Kunz. 175, 1147 (1968)

Theory of Transition-Metal Complexes: Unrestricted Hartree-Fock Molecular-Orbital Method and Its Application to $KNiF_3$—D. E. Ellis, A. J. Freeman, and P. Ros. 176, 688 (1968)

Positron Annihilation in Yttrium and Zirconium—R. P. Gupta and T. L. Loucks. 176, 848 (1968)

Band-Structure Effects and Many-Particle Scattering Corrections in the Far-Ultraviolet Spectra of Ge and Si—David Brust and Evan O. Kane. 176, 894 (1968)

Spin Splitting and the Ultraviolet Absorption of Ge—Luis R. Saravia and David Brust. 176, 915 (1968)

Comments and Addenda: Influence of Band Structure on the Nonlocal Conductivity of Metals and the Anomalous Skin Effect—M. L. Glasser. 176, 1110 (1968)

Separated Two-Component Equations for Spin-$\frac{1}{2}$ Particles Using Foldy-Wouthuysen-Type Transformations with an Application to the k·p Method in Solids—S. Teitler. 176, 1443 (1968)

### 44.2 Electric and Magnetic Susceptibilities and Polarizations (see also 49.8)

Exchange and the Dielectric Screening Function—Leonard Kleinman. 172, 383 (1968)

New Calculation of the Magnetic Susceptibility for the Takano-Ogawa Theory of Kondo's Effect in Dilute Alloys—A. P. Klein. 172, 520 (1968)

**Magnetic Properties of Uranium Compounds with Elements of the VA and VIA Groups. I. Compounds of UX Type**—J. Grunzweig-Genossar, M. Kuznietz, and F. Friedman. 173, 562 (1968)

**Antiferromagnetism and the Magnetic Phase Diagram of $GdAlO_3$**—K. W. Blazey and H. Rohrer. 173, 574 (1968)

**Pressure and Temperature Dependence of the Dielectric Properties of Hydrogen-Bonded Ferroelectrics: $LiH_3(SeO_3)_2$ and $LiD_3(SeO_3)_2$**—G. A. Samara. 173, 605 (1968)

**Erratum: Effective Magnetic Field in Metals**—J. I. Kaplan and M. L. Glasser. [170, 649 (1968)] 173, 918 (1968)

**Electronic Spin Polarization around a Magnetic Impurity Using Perturbation Theory**—H. U. Everts and B. N. Ganguly. 174, 594 (1968)

**Electric-Field-Induced Raman Scattering in $SrTiO_3$ and $KTaO_3$**—P. A. Fleury and J. M. Worlock. 174, 613 (1968)

**Bounds for the Isothermal, Adiabatic, and Isolated Static Susceptibility Tensors**—R. M. Wilcox. 174, 624 (1968)

**Electroreflectance Changes in Dielectric Constants of Au and Ag by Modulated Ellipsometry**—A. B. Buckman and N. M. Bashara. 174, 719 (1968)

**Modification of Friedel Oscillations by a Magnetic Field**—Marvin E. Rensink. 174, 744 (1968)

**Adjusting Poles and Zeros of Dielectric Dispersion to Fit Reststrahlen of $PrCl_3$ and $LaCl_3$**—Dwight W. Berreman and Frank C. Unterwald. 174, 791 (1968)

**180° Domain-Wall Energies in $BaTiO_3$**—W. N. Lawless. 175, 619 (1968)

**Dynamic Susceptibility of Magnetic Ions in Metals**—Yung-Li Wang and D. J. Scalapino. 175, 734 (1968)

**Electron-Spin Susceptibilities of the Liquid Binary Alkali Metal Alloys**—J. A. Kaeck. 175, 897 (1968)

**Van Vleck Paramagnetism in Orthorhombic $TiO_2$ (Brookite)**—Frank E. Senftle and Arthur N. Thorpe. 175, 1144 (1968)

**Coulomb Interactions in an Atomic Dielectric**—G. D. Mahan and R. M. Mazo. 175, 1191 (1968)

## 44.3 Optical Emission and Absorption (see also 11, 12, 22, and 48.7)

Radiative and Multiphonon Relaxation of Rare-Earth Ions in $Y_2O_3$—M. J. Weber. 171, 283 (1968)

Optical Spectrum and Zeeman Effect of $CaF_2:Eu^{2+}$—P. Kisliuk, H. H. Tippins, C. A. Moore, and S. A. Pollack. 171, 336 (1968)

Investigation of Magnetic Interactions in $TbAlO_3$ by Optical Spectroscopy—S. Hüfner, L. Holmes, F. Varsanyi, and L. G. Van Uitert. 171, 507 (1968)

Impurity-Induced Optical Fluorescence in $MnF_2$—R. L. Greene, D. D. Sell, R. S. Feigelson, G. F. Imbusch, and H. J. Guggenheim. 171, 600 (1968)

Erratum: Quantum Theory of Spontaneous Parametric Scattering of Intense Light—T. G. Giallorenzi and C. L. Tang. [166, 225 (1968)] 171, 610 (1968)

Two-Quantum Volume Photoelectric Effect in Sodium—M. C. Teich and G. J. Wolga. 171, 809 (1968)

Optical Properties of Platinum—A. Y-C. Yu, W. E. Spicer, and G. Hass. 171, 834 (1968)

Band Gap of Gallium Phosphide from 0 to 900°K and Light Emission from Diodes at High Temperatures—M. R. Lorenz, G. D. Pettit, and R. C. Taylor. 171, 876 (1968)

Photoelectronic Properties of ZnSe Crystals—Gerald B. Stringfellow and Richard H. Bube. 171, 903 (1968)

Phonon-Assisted Recombination of Free Excitons in Compound Semiconductors—B. Segall and G. D. Mahan. 171, 935 (1968)

Optical Third-Harmonic Generation in Dye Solutions—R. K. Chang and Lee K. Galbraith. 171, 993 (1968)

Polarization Dependence of Two-Photon Absorption in Solids—Todd R. Bader and Albert Gold. 171, 997 (1968)

Faraday Rotation of the CaO *F* Band and 3557 Å Zero-Phonon Peak—James C. Kemp, William M. Ziniker, James A. Glaze, and Jack C. Cheng. 171, 1024 (1968)

Radiative Decay of Coulomb-Stimulated Plasmons in Spheres—Julian Crowell and R. H. Ritchie. 172, 436 (1968)

Anomalous Skin Effect for Specular Electron Scattering and Optical Experiments at Non-Normal Angles of Incidence—K. L. Kliewer and Ronald Fuchs. 172, 607 (1968)

Mechanism for the Photoreflectance Effect—J. G. Gay and L. T. Klauder, Jr. 172, 811 (1968)

Vibrational Structures Accompanying the Optic Transitions of Bound Electrons in Crystals—E. Mulazzi, G. F. Nardelli, and N. Terzi. 172, 847 (1968)

Erratum: Optical Properties of Cobalt—A. Y-C. Yu, T. M. Donovan, and W. E. Spicer. [167, 670 (1968)] 172, 1002 (1968)

Erratum: Photoemission Studies of the Electronic Structure of Cobalt—A. Y-C. Yu and W. E. Spicer. [167, 674 (1968)] 172, 1002 (1968)

Energy Transfer between Chromium Ions in Nonequivalent Sites in $Li_3Ge_7O_{16}$—Richard C. Powell. 173, 358 (1968)

Optical Absorption and Energy Loss in Sodium in the Hartree Approximation—E-Ni Foo and J. J. Hopfield. 173, 635 (1968)

Electro-Optic Measurements of PbS, PbSe, and PbTe—D. E. Aspnes and M. Cardona. 173, 714 (1968)

Photoconductivity Studies of Defects in Silicon: Divacancy-Associated Energy Levels—A. H. Kalma and J. C. Corelli. 173, 734 (1968)

Effects of Current Flow on the Optical Absorption of a Semiconductor—Carl A. Baumgardner and Truman O. Woodruff. 173, 746 (1968)

Symmetry and Reststrahlen in Elemental Crystals—Richard Zallen. 173, 824 (1968)

Some Features of the Temperature Dependence of Infrared Absorption by Localized Vibrational Modes—A. E. Hughes. 173, 860 (1968)

Diffuse and Propagating Modes in the Heisenberg Paramagnet—Herbert S. Bennett. 174, 629 (1968)

Electric-Field Modulation of Luminescence-Excitation in Natural Diamond in the Spectral Energy Range 5.0–6.0 eV—P. Denham and E. C. Lightowlers. 174, 800 (1968)

Decay Modes with Coherent Resonant-Energy Transfer between Deep Impurities in Solids—R. C. Casella. 174, 830 (1968)

Excited States of Bound Exciton Complexes in CdS—D. C. Reynolds, C. W. Litton, and T. C. Collins. 174, 845 (1968)

Urbach's Rule in an Electron-Phonon Model—Dennis Dunn. 174, 855 (1968)

Free-Carrier and Exciton Recombination Radiation in GaAs—M. A. Gilleo, P. T. Bailey, and D. E. Hill. 174, 898 (1968)

Resonance Energy Transfer in Condensed Media from a Many-Particle Viewpoint—John D. Dow. 174, 962 (1968)

Defects in Rutile. III. Optical and Electrical Properties of Impurities and Charge Carriers—O. W. Johnson, W. D. Ohlsen, and Paul I. Kingsbury, Jr. 175, 1102 (1968)

Data and Speculations on the Electronic Problem for the Relaxed Excited *F* Center—L. Bosi, P. Podini, and G. Spinolo. 175, 1133 (1968)

Theory of Impurity-Induced Infrared Absorption—Robert S. Wilson, W. T. King, and Shoon K. Kim. 175, 1164 (1968)

Optical Properties of Free-Electron-Like Foils—R. J. Esposito, Philip E. Bloomfield, and L. Muldawer. 176, 886 (1968)

Band-Structure Effects and Many-Particle Scattering Corrections in the Far-Ultraviolet Spectra of Ge and Si—David Brust and Evan O. Kane. 176, 894 (1968)

Spin Splitting and the Ultraviolet Absorption of Ge—Luis R. Saravia and David Brust. 176, 915 (1968)

Electron-Capture ("Internal") Luminescence from the Oxygen Donor in Gallium Phosphide—P. J. Dean and C. H. Henry. 176, 928 (1968)

Donor-Acceptor Pair Recombination Involving the First Excited State of a Donor in GaAs—Jagdeep Shah, R. C. C. Leite, and J. P. Gordon. 176, 938 (1968)

Thermoreflectance in Semiconductors—E. Matatagui, A. G. Thompson, and Manuel Cardona. 176, 950 (1968)

Bound-Exciton, Free-Exciton, Band-Acceptor, Donor-Acceptor, and Auger Recombination in GaAs—E. Hal Bogardus and H. Barry Bebb. 176, 993 (1968)

## 44.4 Optical Propagation and Properties (see also 23)

Optical Parametric Scattering in Ammonium Dihydrogen Phosphate—Douglas Magde and Herbert Mahr. 171, 393 (1968)

Nonlinear Optical Susceptibilities in Group IV and III-V Semiconductors—Sudhanshu S. Jha and N. Bloembergen. 171, 891 (1968)

Theory of Parametric Gain near a Lattice Resonance—C. H. Henry and C. G. B. Garrett. 171, 1058 (1968)

Theory of Gyrotropic Birefringence—R. M. Hornreich and S. Shtrikman. 171, 1065 (1968)

Second-Harmonic Light Generation in Crystals with Natural Optical Activity—H. J. Simon and N. Bloembergen. 171, 1104 (1968)

Quantum Noise. XI. Multitime Correspondence between Quantum and Classical Stochastic Processes—Melvin Lax. 172, 350 (1968)

Quantum Noise. XIII. Six-Classical-Variable Description of Quantum Laser Fluctuations—Melvin Lax and Horace Yuen. 172, 362 (1968)

Optical Properties of Dilute Ag-In Alloys—R. M. Morgan and D. W. Lynch. 172, 628 (1968)

Effect of Uniaxial and Hydrostatic Strain on the Optical Constants and the Electronic Structure of Copper—Ulrich Gerhardt. 172, 651 (1968)

Reflectance and $1/\epsilon$ Resonance of Beryllium in the Far Ultraviolet—J. Toots, H. A. Fowler, and L. Marton. 172, 670 (1968)

Optical Properties of $VO_2$ between 0.25 and 5 eV—Hans W. Verleur, A. S. Barker, Jr., and C. N. Berglund. 172, 788 (1968)

Piezo-Electroreflectance in Ge, GaAs, and Si—Fred H. Pollak and Manuel Cardona. 172, 816 (1968)

Dispersion in the Nonlinear Susceptibility of GaP near the Reststrahl Band—W. L. Faust, C. H. Henry, and R. H. Eick. 173, 781 (1968)

Raman Spectrum of $LaBr_3$—C. K. Asawa. 173, 869 (1968)

Propagation of an Intense Light Beam in a Nonlinear Medium—Chen-Show Wang. 173, 908 (1968)

Anti-Stokes Generation in Trapped Filaments of Light—C. A. Sacchi, C. H. Townes, and J. R. Lifsitz. 174, 439 (1968)

Electromodulation of the Optical Properties of Gold—Wilford N. Hansen and Arnold Prostak. 174, 500 (1968)

Optical Second-Harmonic Generation in Reflection from Media with Inversion Symmetry—N. Bloembergen, R. K. Chang, S. S. Jha, and C. H. Lee. 174, 813 (1968)

Theory of Optical Parametric Noise—D. A. Kleinman. 174, 1027 (1968)

Spin-Flip Raman Scattering in Cadmium Sulfide—D. G. Thomas and J. J. Hopfield. 175, 1020 (1968)

Application of the Orthogonalized-Plane-Wave Method to Lithium Chloride, Sodium Chloride, and Potassium Chloride—A. Barry Kunz. 175, 1147 (1968)

Symmetrical Formulation of the Quantum Theory of Three-Wave Optical Parametric Interactions—C. Y. She. 176, 461 (1968)

Thermoreflectance in Semiconductors—E. Matatagui, A. G. Thompson, and Manuel Cardona. 176, 950 (1968)

# 45 TRANSPORT PROPERTIES
(see also 33.5 and 4(6-9).5)

## 45.1 Acoustical Propagation (see also 42.3)

Interaction of Acoustic Phonons with Nuclear Spins in $KTaO_3$—E. H. Gregory. 171, 365 (1968)

Phonon Conductivity and Acoustic Attenuation in Si—R. P. Singh and G. S. Verma. 171, 838 (1968)

Nonlinear Theory of Ultrasonic Wave Amplification and Current Saturation in Piezoelectric Semiconductors—P. K. Tien. 171, 970 (1968)

Experimental and Theoretical Study of the Scattering of Phonons by *U* Centers in Alkali Halide Crystals—Lee G. Radosevich and Charles T. Walker. 171, 1004 (1968)

Longitudinal Ultrasonic Attenuation in Pure Strong-Coupling Superconductors. II.—James W. F. Woo. 172, 423 (1968)

Doppler-Shifted Acoustic Cyclotron Resonance in Gallium—J. A. Munarin. 172, 737 (1968)

Effect of Phonon Dispersion on Heat-Pulse Shape—J. M. Andrews, Jr., and M. W. P. Strandberg. 172, 869 (1968)

Erratum: Second-Harmonic Generation of Microwave Phonons in Quartz and Sapphire—Paul H. Carr. [169, 719 (1968)] 173, 325 (1968)

Nonlinear Effect in the Shear-Wave Attenuation near $T_c$ in Superconductors—K. Fossheim. 173, 526 (1968)

Ultrasonic Attenuation near the Critical Point of $MnF_2$—J. R. Neighbours and R. W. Moss. 173, 542 (1968)

Magnetoacoustic Effect in Potassium—J. Roger Peverley. 173, 689 (1968)

Acoustic Attenuation in Solids—R. Kishore. 173, 856 (1968)

Magnetoacoustic Dispersion and Attenuation; Comparison of Experiment with the Free-Electron Theory—A. G. Beattie. 174, 721 (1968)

Current Fluctuations in the Acoustoelectric Steady State—Lionel Friedman. 174, 737 (1968)

Acoustoelectric Effect in Polar Semiconductors—V. V. Paranjape and S. B. Joshi. 174, 919 (1968)

Ultrasonic Attenuation in the Superconducting State of High-Purity Thallium—H. J. Willard, Jr., R. W. Shaw, and G. L. Salinger. 175, 362 (1968)

Ultrasonic Attenuation in the Normal State of High-Purity Thallium—H. J. Willard, Jr. 175, 367 (1968)

Orientation Dependence of Ultrasonic Attenuation in Copper—E. Y. Wang, R. J. Kolouch, and K. A. McCarthy. 175, 723 (1968)

Magnetic Field Dependence of the Velocity of Sound in Ultrapure Cd and Cu—B. G. W. Yee and J. D. Gavenda. 175, 805 (1968)

Ultrasonic Attenuation in Dirty Dielectric Crystals—H. J. Maris. 175, 1077 (1968)

Elastic and Thermal Waves in Solids at Hypersonic Frequencies—Helmut D. Weymann. 176, 838 (1968)

Hypersonic Attenuation in Rutile—James N. Lange. 176, 1030 (1968)

## 45.2 Thermal Conduction (see also 42.3)

Phonon Conductivity and Acoustic Attenuation in Si—R. P. Singh and G. S. Verma. 171, 838 (1968)

Limitation of the Phonon Heat Conductivity by Edge-Dislocation Dipoles, Single Dislocations, and Normal Processes—Peter Gruner and Helmut Bross. 172, 583 (1968)

Effect of Phonon Dispersion on Heat-Pulse Shape—J. M. Andrews, Jr., and M. W. P. Strandberg. 172, 869 (1968)

Thermal Conductivities and Lorenz Functions of Dy, Er, and Lu Single Crystals—D. W. Boys and S. Legvold. 174, 377 (1968)

Calculation of the Effect of Superconducting Energy-Gap Anisotropy on the Thermal Conductivity of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 556 (1968)

Theory of Heat-Pulse Propagation in a Phonon Gas—P. C. Kwok. 175, 1208 (1968)

Elastic and Thermal Waves in Solids at Hypersonic Frequencies—Helmut D. Weymann. 176, 838 (1968)

Lattice Thermal Conductivity for a One-Dimensional, Harmonic, Isotopically Disordered Crystal—Kenneth R. Allen and Joseph Ford. 176, 1046 (1968)

## 45.3 Electrical Conduction (see also 44.1)

Thermoelectric Power of Aluminum and Dilute Aluminum Alloys—R. P. Huebener. 171, 634 (1968)

Electron-Phonon Interactions in Solid Alkali Metals. I. Scattering and Transport Coefficients—John E. Robinson and John D. Dow. 171, 815 (1968)

Photothermal Ionization and Photon-Induced Tunneling in the Acceptor Photoconductivity Spectrum of Semiconducting Diamond—A. T. Collins and E. C. Lightowlers. 171, 843 (1968)

Energy Dependence of Damage Recovery in $n$-Type Ge Electron-Irradiated at 4.2°K—Rudolf E. Penczer and Henry M. DeAngelis. 171, 862 (1968)

Piezoresistance of $n$-Type Magnesium Stannide—L. D. Crossman and G. C. Danielson. 171, 867 (1968)

Electron Transport with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey and J. R. Sybert. 172, 603 (1968)

Conduction-Band Structure of GaSb from Pressure Experiments to 50 kbar—B. B. Kosicki, A. Jayaraman, and William Paul. 172, 764 (1968)

Polarons in Anisotropic Energy Bands—Arnold H. Kahn. 172, 813 (1968)

Field-Controlled Photogeneration and Free-Carrier Transport in Amorphous Selenium Films—Mark D. Tabak and Peter J. Warter, Jr. 173, 899 (1968)

Electrical Resistivity and Screening in Some Dilute Ferromagnetic Nickel Alloys—T. Farrell. 174, 564 (1968)

Pseudopotentials in Alloys and the Calculation of the Residual Resistivity—O. P. Gupta. 174, 668 (1968)

Surface Quantum States and Impedance Oscillations in a Weak Magnetic Field—Numerical Aspects—T. W. Nee, J. F. Koch, and R. E. Prange. 174, 758 (1968)

Transport Properties of GaAs—J. G. Ruch and G. S. Kino. 174, 921 (1968)

Electrical and Optical Enhancement of Photoconductivity in Semi-Insulating GaAs—Jagdeep Shah and Yizhak Yacoby. 174, 932 (1968)

Erratum: Electron Tunneling in Metal-Semiconductor Barriers—J. W. Conley, C. B. Duke, G. D. Mahan, and J. J. Tiemann. [150, 466 (1966)] 174, 1082 (1968)

Size Effect in Electrical Conductivity of Metallic Films with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey, J. R. Sybert, and W. D. Deering. 175, 729 (1968)

Phonon-Limited Resistivity of Some Simple Metals—R. C. Dynes and J. P. Carbotte. 175, 913 (1968)

Influence of Ellipsoidal Energy Surfaces on the Differential Resistance of Schottky Barriers—R. Stratton and F. A. Padovani. 175, 1072 (1968)

Electronic Component of Dislocation Drag in Metals—G. P. Huffman and N. Louat. 176, 773 (1968)

Optical Properties of Free-Electron-Like Foils—R. J. Esposito, Philip E. Bloomfield, and L. Muldawer. 176, 886 (1968)

Electron and Phonon Tunneling Spectroscopy in Metal-Germanium Contacts—F. Steinrisser, L. C. Davis, and C. B. Duke. 176, 912 (1968)

Theory of the Tunneling Spectroscopy of Collective Excitations—Alan J. Bennett, C. B. Duke, and S. D. Silverstein. 176, 969 (1968)

Ionic Transport in Potassium Chloride—Robert G. Fuller, Charles L. Marquardt, Michael H. Reilly, and John C. Wells, Jr. 176, 1036 (1968)

Comments and Addenda: Influence of Band Structure on the Nonlocal Conductivity of Metals and the Anomalous Skin Effect—M. L. Glasser. 176, 1110 (1968)

## 45.4 Magneto-Transport Effects (see also 44.1)

Helicon Waves, Surface-Mode Loss, and the Accurate Determination of the Hall Coefficients of Aluminum, Indium, Sodium, and Potassium—John M. Goodman. 171, 641 (1968)

Three Geometrical Modifications of the Surface-Impedance Experiment in Low Magnetic Fields—R. E. Prange. 171, 737 (1968)

Magnetoresistance of Potassium—John R. Reitz and A. W. Overhauser. 171, 749 (1968)

Quantum Theory of Electrical Transport in a Magnetic Field. I—R. B. Thomas, Jr. 171, 827 (1968)

Size-Dependent Oscillatory Magnetoresistance Effect in Gallium—J. A. Munarin, J. A. Marcus, and Philip E. Bloomfield. 172, 718 (1968)

Strain-Dependent Magnetoresistance of Potassium—P. A. Penz and R. Bowers. 172, 991 (1968)

Magnetoacoustic Effect in Potassium—J. Roger Peverley. 173, 689 (1968)

Magnetic Energy Levels in an Energy Band with Inversion Asymmetry Splitting—Laura M. Roth. 173, 755 (1968)

Magnetoresistance of Undoped $n$-Type Gallium Arsenide at Low Temperatures—L. Halbo and R. J. Sladek. 173, 794 (1968)

Hall Coefficients of Cu, Ag, and Au in the Range 4.2–300°K—J. E. A. Alderson, T. Farrell, and C. M. Hurd. 174, 729 (1968)

Effects of Finite Boundaries on a One-Dimensional Harmonic Oscillator—Richard Vawter. 174, 749 (1968)

Surface Quantum States and Impedance Oscillations in a Weak Magnetic Field—Numerical Aspects—T. W. Nee, J. F. Koch, and R. E. Prange. 174, 758 (1968)

Effects of a Tilted Magnetic Field on a Two-Dimensional Electron Gas—F. F. Fang and P. J. Stiles. 174, 823 (1968)

Low-Field Mobility and Galvanomagnetic Properties of Holes in Germanium with Phonon Scattering—P. Lawaetz. 174, 867 (1968)

Transport Theory in Strong Magnetic Fields—H. F. Budd. 175, 241 (1968)

Spin Relaxation and Transport in Magnetic Alloys—Peter Fulde and Alan Luther. 175, 337 (1968)

**Magnetic Field Dependence of the Velocity of Sound in Ultrapure Cd and Cu**—B. G. W. Yee and J. D. Gavenda. 175, 805 (1968)

**Influence of Localized Umklapp Scattering on the Galvanomagnetic Properties of Metals**—Richard A. Young. 175, 813 (1968)

**Anisotropic Relaxation Times and the Hall Coefficients of α-Phase Alloys of the *IB* Metals**—R. D. Barnard, J. E. A. Alderson, T. Farrell, and C. M. Hurd. 176, 761 (1968)

**Fermi Surface of Potassium as Measured by Helicon Doppler-Shifted Cyclotron Resonance**—P. A. Penz and Toshinoto Kushida. 176, 804 (1968)

**Size Effect in the Electrical Conductivity of Cylindrical Wires**—H. J. Mackey, W. D. Deering, and J. R. Sybert. 176, 856 (1968)

**Anomalous Size Effects in the Galvanomagnetic Properties of Zinc Caused by Compensation**—Stephen B. Soffer. 176, 861 (1968)

**Hall Measurements in Liquid Thallium-Tellurium**—James M. Donally and Melvin Cutler. 176, 1003 (1968)

## 46 METALS AND SEMIMETALS (see also 49)

### 46.1 Collective and Critical Effects (see also 41)

**Absence of Magnetic Ordering in One and Two Dimensions in a Many-Band Model for Interacting Electrons in a Metal**—M. B. Walker and Th. W. Ruijgrok. 171, 513 (1968)

**Further Investigation of Local Moments in Metals**—M. Levine and H. Suhl. 171, 567 (1968)

**Helicon Waves, Surface-Mode Loss, and the Accurate Determination of the Hall Coefficients of Aluminum, Indium, Sodium, and Potassium**—John M. Goodman. 171, 641 (1968)

**Optical Properties of Zn**—L. P. Mosteller, Jr. and F. Wooten. 171, 743 (1968)

**Plasmons and Zeroth Sound in the Electron Gas**—L. L. Van Zandt. 172, 372 (1968)

**Exchange and the Dielectric Screening Function**—Leonard Kleinman. 172, 383 (1968)

**Fermi-Liquid Effects on Plasma Wave Propagation in Metals**—S. C. Ying and J. J. Quinn. 173, 473 (1968)

**Sum Rule for the Landau Fermi-Liquid Parameters in Metals**—W. F. Brinkman, P. M. Platzman, and T. M. Rice. 174, 495 (1968)

**Search for Plasmaron Structure in the Soft X-Ray $L_{2,3}$ Emission Spectrum of Al**—J. R. Cuthill, R. C. Dobbyn, A. J. McAlister, and M. L. Williams. 174, 515 (1968)

**Effects of Electron-Electron Interactions on Nuclear Spin-Lattice Relaxation Rates and Knight Shifts in Alkali and Noble Metals**—Albert Narath and H. T. Weaver. 175, 373 (1968)

**Landau Fermi-Liquid Parameters in Na and K**—T. M. Rice. 175, 858 (1968)

**Renormalization of Critical Exponents by Hidden Variables**—Michael E. Fisher. 176, 257 (1968)

**Circular One-Dimensional Model for the Electron-Ion System. I. Random-Phase Approximation**—Gideon Carmi. 176, 510 (1968)

**Circular One-Dimensional Model for the Electron-Ion System. II. First-Order Phase Transitions in the Random-Phase Approximation**—Gideon Carmi. 176, 521 (1968)

**Simple Microscopic Theory of Surface Plasmons**—Peter J. Feibelman. 176, 551 (1968)

**Electron Correlations at Metallic Densities**—K. S. Singwi, M. P. Tosi, R. H. Land, and A. Sjölander. 176, 589 (1968)

### 46.2 Crystal Structure and Properties (see also 42)

**Multiphonon Scattering of Low-Energy Electrons**—Robert F. Barnes, Max G. Lagally, and Maurice B. Webb. 171, 627 (1968)

**Structure Dependence of *d* Bands in Transition Metals**—R. A. Deegan. 171, 659 (1968)

**Correlation Functions of Disordered Binary Alloys. II**—Philip C. Clapp and S. C. Moss. 171, 754 (1968)

**Correlation Functions of Disordered Binary Alloys. III**—S. C. Moss and Philip C. Clapp. 171, 764 (1968)

**Shock Compression of Argon and Xenon. IV. Conversion of Xenon to a Metal-Like State**—Marvin Ross. 171, 777 (1968)

**Examination of the Thermal Variation of the Mean Square Atomic Displacements in Zinc and Evaluation of the Associated Debye Temperature**—Earl F. Skelton and J. Lawrence Katz. 171, 801 (1968)

**Low-Temperature Amplitude-Independent Longitudinal Ultrasonic Attenuation in Normal Lead**—W. A. Fate. 172, 402 (1968)

**Effect of Pressure on *f* Number and Isomer Shift for $Fe^{57}$ in Cu, V, and Ti**—J. A. Moyzis, Jr., G. DePasquali, and H. G. Drickamer. 172, 665 (1968)

**Temperature-Dependent Isomer Shift and Anharmonic Binding of $Sn^{119}$ in $Nb_3Sn$ from Mössbauer-Effect Measurements**—J. S. Shier and R. D. Taylor. 174, 346 (1968)

**Specific Heat and Grüneisen $\gamma$ of Noble Metals**—Rajendra P. Gupta. 174, 714 (1968)

**Specific Heats of Cu, GaAs, GaSb, InAs, and InSb from 1 to 30°K**—T. C. Cetas, C. R. Tilford, and C. A. Swenson. 174, 835 (1968)

**Measurement of Higher-Order Elastic Constants, Using Finite Deformations**—B. E. Powell and M. J. Skove. 174, 977 (1968)

**Erratum: Specific Heats below 3°K of Pure Copper, Silver, and Gold and of Extremely Dilute Gold-Transition-Metal Alloys**—Douglas L. Martin. [170, 650 (1968)] 174, 1082 (1968)

**Second- and Third-Order Elastic Constants of Alkali Metals**—Tetsuro Suzuki, A. V. Granato, and J. F. Thomas, Jr. 175, 766 (1968)

**Simplified Theory of Anharmonic Contributions to the Thermodynamic Properties of Solid Sodium Metal**—D. John Pastine. 175, 905 (1968)

**Third-Order Elastic Constants of Aluminum**—J. F. Thomas, Jr. 175, 955 (1968)

**Intensity of Forbidden Neutron Reflections Simulated by Multiple Bragg Reflection**—D. A. Kottwitz. 175, 1056 (1968)

**Dielectric Screening and the Phonon Spectra of Metallic and Nonmetallic Crystals**—P. N. Keating. 175, 1171 (1968)

**Electromigration in Zinc Single Crystals**—J. L. Routbort, 176, 796 (1968)

**Pseudopotential Calculation of the Thermal Expansion Coefficient of Sodium and Potassium**—Duane C. Wallace. 176, 832 (1968)

### 46.3 Imperfections and Impurities; Alloys (see also 43)

**Theory of *s-d* Scattering in Dilute Magnetic Alloys with Spin-$\frac{1}{2}$ Impurities**—H. J. Spencer. 171, 515 (1968)

**Nuclear Magnetic Resonance in Dilute Alloys of Indium-Lead and Indium-Tin**—W. T. Anderson, Jr., F. C. Thatcher, and R. R. Hewitt. 171, 541 (1968)

**Ferromagnetism of $CrBe_{12}$**—N. M. Wolcott and R. L. Falge, Jr. 171, 591 (1968)

**Solute Knight Shifts in Noble Metals**—Lawrence H. Bennett, R. W. Mebs, and R. E. Watson. 171, 611 (1968)

Thermoelectric Power of Aluminum and Dilute Aluminum Alloys—R. P. Huebener. 171, 634 (1968)

Theory of Localized Vibrations of Interstitial Atoms in bcc Lattices—G. Blaesser, J. Peretti, and G. Toth. 171, 665 (1968)

Self-Consistent-Field Approximations in Disordered Alloys—P. L. Leath. 171, 725 (1968)

Lattice Dynamics of Niobium-Molybdenum Alloys—B. M. Powell, P. Martel, and A. D. B. Woods. 171, 727 (1968)

Ground State of the Magnetic Impurity Problem; Nuclear-Magnetic-Resonance Studies of Dilute Copper Alloys—A. J. Heeger, L. B. Welsh, M. A. Jensen, and G. Gladstone. 172, 302 (1968)

Structure-Factor Approach to Migration Energy of Interstitials—Michael D. Feit and H. B. Huntington. 172, 580 (1968)

Optical Properties of Dilute Ag-In Alloys—R. M. Morgan and D. W. Lynch. 172, 628 (1968)

Theory of the Vibrations of Dilute Alloys with Short-Range Order—W. M. Hartmann. 172, 677 (1968)

Lattice Heat Conductivity in Annealed and Quenched Gold-Platinum Alloys—C. van Baarle and R. P. Huebener. 172, 699 (1968)

Low-Temperature Specific Heat of Face-Centered Cubic Ni-Co Alloys—James C. Ho and R. Viswanathan. 172, 705 (1968)

Strain-Dependent Magnetoresistance of Potassium—P. A. Penz and R. Bowers. 172, 991 (1968)

Erratum: Electrical Resistivity and Thermoelectric Power of CuAu Alloy—K. Teramoto and M. Tachiki. [166, 656 (1968)] 172, 1002 (1968)

Kondo Problem at Low Temperatures—S. Doniach. 173, 599 (1968)

Transmission Electron Spin Resonance in Dilute Copper-Chromium Alloys—P. Monod and S. Schultz. 173, 645 (1968)

Lattice-Dynamical Properties of $Fe^{57}$ Impurity Atoms in Pt, Pd, and Cu from Precision Measurements of Mössbauer Fractions—Rudi H. Nussbaum, Donald G. Howard, Wilbur L. Nees, and Charles F. Steen. 173, 653 (1968)

Comparison of Defects Injected into Platinum by Quenching and by Radiation Doping—J. J. Jackson and K. Herschbach. 173, 664 (1968)

Magnetoresistance of Dilute Alloys—H. Rohrer. 174, 583 (1968)

Pseudopotentials in Alloys and the Calculation of the Residual Resistivity—O. P. Gupta. 174, 668 (1968)

Kinetic Study of Vacancy Clustering and Annealing in Metals—R. A. Johnson. 174, 684 (1968)

Recovery of Resistivity of Pure and Alloyed Aluminum in Stages II and III after 2-MeV Electron Irradiation—P. B. Peters and P. E. Shearin. 174, 691 (1968)

Direct Observation of Solid-State Diffusion Using the Mössbauer Effect—Robert C. Knauer and James G. Mullen. 174, 711 (1968)

Erratum: Specific Heats below 3°K of Pure Copper, Silver, and Gold and of Extremely Dilute Gold-Transition-Metal Alloys—Douglas L. Martin. [170, 650 (1968)] 174, 1082 (1968)

Effect of Antimony, Indium, and Zinc Impurities on the Critical-Field Curve of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 543 (1968)

Anisotropy of the Residual Resistivity of Tin with Sb, In, Zn, and Cd Impurities, and the Ideal Resistivities and Deviations from Matthiessen's Rule at 77 and 273°K—F. V. Burckbuchler and C. A. Reynolds. 175, 550 (1968)

Application of the Cluster Variation Method to the *s-d* Interaction Hamiltonian—James Halow, Tomoyasu Tanaka, and Tohru Morita. 175, 680 (1968)

Erratum: Nuclear Magnetic Resonance and Relaxation of $^{197}Au$ in Gold Metal and $^{109}Ag$ in Gold-Silver Alloys—Albert Narath. [163, 232 (1967)] 175, 696 (1968)

Ordering Energy and Effective Pairwise Interactions in a Binary Alloy of Simple Metals—Timothy M. Hayes, Harvey Brooks, and Arthur Bienenstock. 175, 699 (1968)

Isotope Effect for Diffusion of Iron in Vanadium—M. G. Coleman, C. A. Wert, and R. F. Peart. 175, 788 (1968)

Effect of Force-Constant Changes on the Incoherent Neutron Scattering from Cubic Crystals with Point Defects—Katja Lakatos and J. A. Krumhansl. 175, 841 (1968)

Electron-Spin Susceptibilities of the Liquid Binary Alkali Metal Alloys—J. A. Kaeck. 175, 897 (1968)

Application of the Method of Lattice Statics to Interstitial Cu Atoms in Cu—John W. Flocken and John R. Hardy. 175, 919 (1968)

Ground-State Energy of the Anderson Model by the Cluster Variation Method—Shyamalendu M. Bose and Tomoyasu Tanaka. 176, 600 (1968)

Electronic Component of Dislocation Drag in Metals—G. P. Huffman and N. Louat. 176, 773 (1968)

Stage-III Annealing in Gold after Electron Irradiation—C. Lee and J. S. Koehler. 176, 813 (1968)

Determination of the Number of Unique Configurations of Unrelaxed Clusters in Crystal Lattices—A. P. Brody and M. Meshii. 176, 845 (1968)

High-Temperature Recovery of Tungsten after Neutron Irradiation—L. K. Keys, J. P. Smith, and J. Moteff. 176, 851 (1968)

Phonon-Assisted Impurity Scattering in Gold Alloys—D. H. Damon, M. P. Mathur, and P. G. Klemens. 176, 876 (1968)

## 46.4 Electronic Structure and Properties (see also 44)

Solute Knight Shifts in Noble Metals—Lawrence H. Bennett, R. W. Mebs, and R. E. Watson. 171, 611 (1968)

Structure Dependence of *d* Bands in Transition Metals—R. A. Deegan. 171, 659 (1968)

Conduction-Electron Exchange and the Local Pseudopotential Form Factors in the Alkali Metals—Warren D. Grobman. 171, 673 (1968)

Fermi Momentum of Aluminum from 0 to 100 kbar—J. J. Burton and G. Jura. 171, 699 (1968)

Study of the Radio-Frequency Size Effect in Potassium—P. S. Peercy, W. M. Walsh, Jr., L. W. Rupp, Jr., and P. H. Schmidt. 171, 713 (1968)

Optical Properties of Zn—L. P. Mosteller, Jr. and F. Wooten. 171, 743 (1968)

Self-Consistent Energy Bands of Metallic Copper by the Augmented-Plane-Wave Method. II.—E. C. Snow. 171, 785 (1968)

X-Ray Determination of Electron Momenta in Li, Be, B, Na, Mg, Al, and LiF—Walter C. Phillips and R. J. Weiss. 171, 790 (1968)

Two-Quantum Volume Photoelectric Effect in Sodium—M. C. Teich and G. J. Wolga. 171, 809 (1968)

Optical Properties of Platinum—A. Y-C. Yu, W. E. Spicer, and G. Hass. 171, 834 (1968)

Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)

Gravitationally Induced Electric Field near a Conductor, and Its Relation to the Surface-Stress Concept—Conyers Herring. 171, 1361 (1968)

Symmetry of the Wave Functions in the Band Theory of Ferromagnetic Metals—L. M. Falicov and J. Ruvalds. 172, 498 (1968)

de Haas–van Alphen Effect, Exchange Splitting, Spin-Orbit Interaction, and Magnetic Breakdown in Ferromagnetic Nickel—J. Ruvalds and L. M. Falicov. 172, 508 (1968)

Tilt of the Electron Fermi Surface in Bi—R. D. Brown, R. L. Hartman, and S. H. Koenig. 172, 598 (1968)

Anomalous Skin Effect for Specular Electron Scattering and Optical Experiments at Non-Normal Angles of Incidence —K. L. Kliewer and Ronald Fuchs. 172, 607 (1968)

Effect of Uniaxial and Hydrostatic Strain on the Optical Constants and the Electronic Structure of Copper—Ulrich Gerhardt. 172, 651 (1968)

Reflectance and $1/\epsilon$ Resonance of Beryllium in the Far Ultraviolet—J. Toots, H. A. Fowler, and L. Marton. 172, 670 (1968)

Fermi-Liquid Effects on High-Frequency Wave Propagation in Simple Metals—P. M. Platzman, W. M. Walsh, Jr., and E-Ni Foo. 172, 689 (1968)

Low-Temperature Specific Heat of Face-Centered Cubic Ni-Co Alloys—James C. Ho and R. Viswanathan. 172, 705 (1968)

Self-Consistent Energy Bands of Silver by an Augmented-Plane-Wave Method—E. C. Snow. 172, 708 (1968)

Knight Shift in Single-Crystal Mercury—R. W. Weinert and R. T. Schumacher. 172, 711 (1968)

Doppler-Shifted Acoustic Cyclotron Resonance in Gallium—J. A. Munarin. 172, 737 (1968)

Screening and Electron Correlation Effects on the Electron-Phonon Interaction in Monovalent Metal—Hiroshi Takahashi. 172, 747 (1968)

Optical Properties of $VO_2$ between 0.25 and 5 eV—Hans W. Verleur, A. S. Barker, Jr., and C. N. Berglund. 172, 788 (1968)

Strain-Dependent Magnetoresistance of Potassium—P. A. Penz and R. Bowers. 172, 991 (1968)

Erratum: Optical Properties of Cobalt—A. Y-C. Yu, T. M. Donovan, and W. E. Spicer. [167, 670 (1968)] 172, 1002 (1968)

Erratum: Photoemission Studies of the Electronic Structure of Cobalt—A. Y-C. Yu and W. E. Spicer. [167, 674 (1968)] 172, 1002 (1968)

Heat Capacity of $\alpha$-Manganese from 0.2 to 0.4°K—B. D. Martin and C. V. Heer. 173, 631 (1968)

Optical Absorption and Energy Loss in Sodium in the Hartree Approximation—E-Ni Foo and J. J. Hopfield. 173, 635 (1968)

High-Field Galvanomagnetic Properties of Niobium—W. A. Reed and R. R. Soden. 173, 677 (1968)

Steady-State, ac-Temperature Calorimetry—Paul F. Sullivan and G. Seidel. 173, 679 (1968)

Erratum: Effective Magnetic Field in Metals—J. I. Kaplan and M. L. Glasser. [170, 649 (1968)] 173, 918 (1968)

Electromodulation of the Optical Properties of Gold—Wilford N. Hansen and Arnold Prostak. 174, 500 (1968)

New Foundation for the Use of Pseudopotentials in Metals—William A. Goddard, III. 174, 659 (1968)

Form Factors of Truncated Atomic Potentials—J. C. Phillips and R. Sandrock. 174, 663 (1968)

Fermi Surface of Cadmium: Radio-Frequency Size Effect—R. C. Jones, R. G. Goodrich, and L. M. Falicov. 174, 672 (1968).

Specific Heat and Grüneisen $\gamma$ of Noble Metals—Rajendra P. Gupta. 174, 714 (1968)

Electroreflectance Changes in Dielectric Constants of Au and Ag by Modulated Ellipsometry—A. B. Buckman and N. M. Bashara. 174, 719 (1968)

Magnetoacoustic Dispersion and Attenuation; Comparison of Experiment with the Free-Electron Theory—A. G. Beattie. 174, 721 (1968)

Hall Coefficients of Cu, Ag, and Au in the Range 4.2–300°K —J. E. A. Alderson, T. Farrell, and C. M. Hurd. 174, 729 (1968)

Optimum Form of a Modified Heine-Abarenkov Model Potential for the Theory of Simple Metals—Robert W. Shaw, Jr. 174, 769 (1968)

Anisotropy of Magnetoacoustic Attenuation and Deformation Potential in Bismuth—K. Walther. 174, 782 (1968)

Ultrasonic Attenuation in the Superconducting State of High-Purity Thallium—H. J. Willard, Jr., R. W. Shaw, and G. L. Salinger. 175, 362 (1968)

Ultrasonic Attenuation in the Normal State of High-Purity Thallium—H. J. Willard, Jr. 175, 367 (1968)

de Haas–van Alphen Effect in Antiferromagnetic Chromium —J. E. Graebner and J. A. Marcus. 175, 659 (1968)

Single-Site Approximations in the Electronic Theory of Simple Binary Alloys—B. Velický, S. Kirkpatrick, and H. Ehrenreich. 175, 747 (1968)

Band Structure and Electronic Properties of Silver—P. E. Lewis and P. M. Lee. 175, 795 (1968)

Landau Fermi-Liquid Parameters in Na and K—T. M. Rice. 175, 858 (1968)

Azbel'-Kaner Cyclotron Resonance in Mercury—A. E. Dixon and W. R. Datars. 175, 928 (1968)

Fermi Surface and Electronic Structure of Indium—N. W. Ashcroft and W. E. Lawrence. 175, 938 (1968)

Nuclear Magnetic Resonance in the Metal $ReO_3$: $^{185}$Re and $^{187}$Re Knight Shifts and Spin Relaxation Rates—Albert Narath and D. C. Barham. 176, 479 (1968)

Magnetic Properties of Gold-Rich Gold-Vanadium Alloys—L. Creveling, Jr., and H. L. Luo. 176, 614 (1968)

Specific Heat of Uranium Mononitride from 1.3 to 4.6°K—J. O. Scarbrough, H. L. Davis, W. Fulkerson, and J. O. Betterton, Jr. 176, 666 (1968)

High-Field Galvanomagnetic Effects in Antiferromagnetic Chromium—A. J. Arko, J. A. Marcus, and W. A. Reed. 176, 671 (1968)

Absolute de Haas–van Alphen Frequency Measurements in Potassium—R. L. Thomas and G. Turner. 176, 768 (1968)

Specific Heat below 3°K of Silver-Gold Alloys—Douglas L. Martin. 176, 790 (1968)

Fermi Surface of Potassium as Measured by Helicon Doppler-Shifted Cyclotron Resonance—P. A. Penz and Toshinoto Kushida. 176, 804 (1968)

Band Model for Bismuth-Antimony Alloys—Stuart Golin. 176, 830 (1968)

Positron Annihilation in Yttrium and Zirconium—R. P. Gupta and T. L. Loucks. 176, 848 (1968)

X-Ray Determination of the Electron Momentum Density in Diamond, Graphite, and Carbon Black—Richard J. Weiss and Walter C. Phillips. 176, 900 (1968)

## 46.5 Transport Properties (see also 45)

Theory of $s$-$d$ Scattering in Dilute Magnetic Alloys with Spin-$\frac{1}{2}$ Impurities—H. J. Spencer. 171, 515 (1968)

Thermoelectric Power of Aluminum and Dilute Aluminum Alloys—R. P. Huebener. 171, 634 (1968)

Study of the Radio-Frequency Size Effect in Potassium—P. S. Peercy, W. M. Walsh, Jr., L. W. Rupp, Jr., and P. H. Schmidt. 171, 713 (1968)

Three Geometrical Modifications of the Surface-Impedance Experiment in Low Magnetic Fields—R. E. Prange. 171, 737 (1968)

Magnetoresistance of Potassium—John R. Reitz and A. W. Overhauser. 171, 749 (1968)

Electron-Phonon Interactions in Solid Alkali Metals. I. Scattering and Transport Coefficients—John E. Robinson and John D. Dow. 171, 815 (1968)

Quantum Theory of Electrical Transport in a Magnetic Field. I—R. B. Thomas, Jr. 171, 827 (1968)

Longitudinal Ultrasonic Attenuation in Pure Strong-Coupling Superconductors. II.—James W. F. Woo. 172, 423 (1968)

Lattice Heat Conductivity in Annealed and Quenched Gold-Platinum Alloys—C. van Baarle and R. P. Huebener. 172, 699 (1968)

Size-Dependent Oscillatory Magnetoresistance Effect in Gallium—J. A. Munarin, J. A. Marcus, and Philip E. Bloomfield. 172, 718 (1968)

Doppler-Shifted Acoustic Cyclotron Resonance in Gallium—J. A. Munarin. 172, 737 (1968)

Erratum: Electrical Resistivity and Thermoelectric Power of CuAu Alloy—K. Teramoto and M. Tachiki. [166, 656 (1968)] 172, 1002 (1968)

Magnetoacoustic Effect in Potassium—J. Roger Peverley. 173, 689 (1968)

Thermal Conductivities and Lorenz Functions of Dy, Er, and Lu Single Crystals—D. W. Boys and S. Legvold. 174, 377 (1968)

Sum Rule for the Landau Fermi-Liquid Parameters in Metals—W. F. Brinkman, P. M. Platzman, and T. M. Rice. 174, 495 (1968)

Lattice Thermal Conductivity, Nernst-Ettinghausen Effect, and Specific Heat in Antimony at Low Temperature—R. S. Blewer, N. H. Zebouni, and C. G. Grenier. 174, 700 (1968)

Hall Coefficients of Cu, Ag, and Au in the Range 4.2–300°K—J. E. A. Alderson, T. Farrell, and C. M. Hurd. 174, 729 (1968)

Surface Quantum States and Impedance Oscillations in a Weak Magnetic Field—Numerical Aspects—T. W. Nee, J. F. Koch, and R. E. Prange. 174, 758 (1968)

Anisotropy of Magnetoacoustic Attenuation and Deformation Potential in Bismuth—K. Walther. 174, 782 (1968)

Calculation of the Effect of Superconducting Energy-Gap Anisotropy on the Thermal Conductivity of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 556 (1968)

Ultrasonic Investigation of the Isolated-Vortex State near $H_{c1}$ in Vanadium—A. C. E. Sinclair and J. R. Leibowitz. 175, 596 (1968)

Orientation Dependence of Ultrasonic Attenuation in Copper—E. Y. Wang, R. J. Kolouch, and K. A. McCarthy. 175, 723 (1968)

Size Effect in Electrical Conductivity of Metallic Films with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey, J. R. Sybert, and W. D. Deering. 175, 729 (1968)

Magnetic Field Dependence of the Velocity of Sound in Ultrapure Cd and Cu—B. G. W. Yee and J. D. Gavenda. 175, 805 (1968)

Influence of Localized Umklapp Scattering on the Galvanomagnetic Properties of Metals—Richard A. Young. 175, 813 (1968)

Electron-Hole Recombination in Bismuth—A. A. Lopez. 175, 823 (1968)

Phonon-Limited Resistivity of Some Simple Metals—R. C. Dynes and J. P. Carbotte. 175, 913 (1968)

Azbel'-Kaner Cyclotron Resonance in Mercury—A. E. Dixor and W. R. Datars. 175, 928 (1968)

Anisotropic Relaxation Times and the Hall Coefficients of α-Phase Alloys of the *IB* Metals—R. D. Barnard, J. E. A. Alderson, T. Farrell, and C. M. Hurd. 176, 761 (1968)

Anomalous Size Effects in the Galvanomagnetic Properties of Zinc Caused by Compensation—Stephen B. Soffer. 176, 861 (1968)

Thermal and Electrical Conductivities of Very-High-Purity Indium—M. E. de la Cruz, F. de la Cruz, J. M. Cotignola, O. J. Bressan, and C. A. Luengo. 176, 871 (1968)

Phonon-Assisted Impurity Scattering in Gold Alloys—D. H. Damon, M. P. Mathur, and P. G. Klemens. 176, 876 (1968)

## 46.6 Atoms, Nuclei, and Particles in Metals (see also 20)

Assumption-Independent Single-Particle Wave Function for Positrons in Solids: Applications to Angular Distributions in Al and Si—D. Stroud and H. Ehrenreich. 171, 399 (1968)

Erratum: Electron Longitudinal Depolarization with Great Energy Loss—L. Braicovich, B. De Michelis, and A. Fasana. [164, 1360 (1967)] 171, 1330 (1968)

Effect of Pressure on *f* Number and Isomer Shift for $Fe^{57}$ in Cu, V, and Ti—J. A. Moyzis, Jr., G. DePasquali, and H. G. Drickamer. 172, 665 (1968)

Knight Shift in Single-Crystal Mercury—R. W. Weinert and R. T. Schumacher. 172, 711 (1968)

Radiationless Annihilation of Positrons in Lead—Sakae Shimizu, Takeshi Mukoyama, and Yasuyuki Nakayama. 173, 405 (1968)

Coulomb-Recoil-Implantation Mössbauer Experiments with $^{73}Ge$—Gordon Czjzek, J. L. C. Ford, Jr., John C. Love, Felix E. Obenshain, and Horst H. F. Wegener. 174, 331 (1968)

Magnetic Field Dependence of the Ruderman-Kittel-Kasuya-Yosida Exchange Interaction—M. L. Glasser. 174, 424 (1968)

Scattering of β Radiation on a Thick Foil: Production of Transverse Polarization—L. Braicovich, B. De Michelis, and A. Fasana. 174, 460 (1968)

Effects of Electron–Electron Interactions on Nuclear Spin-Lattice Relaxation Rates and Knight Shifts in Alkali and Noble Metals—Albert Narath and H. T. Weaver. 175, 373 (1968)

Erratum: Nuclear Magnetic Resonance and Relaxation of $^{197}Au$ in Gold Metal and $^{109}Ag$ in Gold–Silver Alloys—Albert Narath. [163, 232 (1967)] 175, 696 (1968)

Characteristic Energy Losses of 8-keV Electrons in Liquid Al, Bi, In, Ga, Hg, and Au—C. J. Powell. 175, 972 (1968)

Theory of Paramagnetic Impurity Spin Resonance in Metals—M. B. Walker. 176, 432 (1968)

Nuclear Magnetic Resonance in the Metal $ReO_3$: $^{185}Re$ and $^{187}Re$ Knight Shifts and Spin Relaxation Rates—Albert Narath and D. C. Barham. 176, 479 (1968)

Specific Heat below 3°K of Silver-Gold Alloys—Douglas L. Martin. 176, 790 (1968)

Differential Range Study of $(\alpha,xn)$ Reactions of Copper—N. T. Porile and I. Fujiwara. 176, 1166 (1968)

## 46.7 Semimetals

Tilt of the Electron Fermi Surface in Bi—R. D. Brown, R. L. Hartman, and S. H. Koenig. 172, 598 (1968)

Electron Transport with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey and J. R. Sybert. 172, 603 (1968)

Lattice Thermal Conductivity, Nernst-Ettinghausen Effect, and Specific Heat in Antimony at Low Temperature—R. S. Blewer, N. H. Zebouni, and C. G. Grenier. 174, 700 (1968)

Anisotropy of Magnetoacoustic Attenuation and Deformation Potential in Bismuth—K. Walther. 174, 782 (1968)

Band Model for Bismuth-Antimony Alloys—Stuart Golin. 176, 830 (1968)

## 47 SEMICONDUCTORS

### 47.1 Collective and Critical Effects (see also 41)

Effect of Nonparabolicity on Light Scattering from Plasmas in Solids—P. A. Wolff. 171, 436 (1968)

Dielectric Singularity of α-Sn—L. Liu and David Brust. 173, 777 (1968)

Light Scattering from a Plasma in a Magnetic Field—P. M. Platzman, P. A. Wolff, and N. Tzoar. 174, 489 (1968)

Magnon Corrections to the Effective Mass of an Electron in a Magnetic Semiconductor—Robert M. White and Roy B. Woolsey. 176, 908 (1968)

### 47.2 Crystal Structure and Properties (see also 42)

Phonon Dispersion Curves by Raman Scattering in SiC, Polytypes 3*C*, 4*H*, 6*H*, 15*R*, and 21*R*—D. W. Feldman, James H. Parker, Jr., W. J. Choyke, and Lyle Patrick. 173, 787 (1968)

Optical Phonons and Dynamic Charge in Trigonal Se and Te—Inan Chen and Richard Zallen. 173, 833 (1968)

Specific Heats of Cu, GaAs, GaSb, InAs, and InSb from 1 to 30°K—T. C. Cetas, C. R. Tilford, and C. A. Swenson. 174, 835 (1968)

Correlation between Mössbauer Resonance Strength and Second-Order Doppler Shift: Estimate of Zero-Point Velocity—R. Dean Taylor and Paul P. Craig. 175, 782 (1968)

Intensity of Forbidden Neutron Reflections Simulated by Multiple Bragg Reflection—D. A. Kottwitz. 175, 1056 (1968)

Electron and Phonon Tunneling Spectroscopy in Metal-Germanium Contacts—F. Steinrisser, L. C. Davis, and C. B. Duke. 176, 912 (1968)

Erratum: Role of Longitudinal and Transverse Phonons in Lattice Thermal Conductivity of GaAs and InSb—C. M. Bhandari and G. S. Verma. [140, A2101 (1965)] 176, 1112 (1968)

### 47.3 Imperfections and Impurities; Doping (see also 43)

Characteristics of Neutron Damage in Silicon—L. J. Cheng and J. Lori. 171, 856 (1968)

Energy Dependence of Damage Recovery in *n*-Type Ge Electron-Irradiated at 4.2°K—Rudolf E. Penczer and Henry M. DeAngelis. 171, 862 (1968)

Band Gap of Gallium Phosphide from 0 to 900°K and Light Emission from Diodes at High Temperatures—M. R. Lorenz, G. D. Pettit, and R. C. Taylor. 171, 876 (1968)

Calculation of the Deformation Energy of a Schottky Defect in Germanium—C. J. Hwang and L. A. K. Watt. 171, 958 (1968)

Steady-State Photoconductivity in the Presence of Traps—O. L. Curtis, Jr. 172, 773 (1968)

Electroreflectance Studies of InAs, GaAs, and (Ga,In)As Alloys—E. W. Williams and Victor Rehn. 172, 798 (1968)

Paramagnetic-Resonance Studies of Rare-Earth Impurities in II-VI Compounds—R. K. Watts and W. C. Holton. 173, 417 (1968)

Photogeneration of Carriers in Vitreous Selenium—D. M. Pai and S. W. Ing, Jr. 173, 729 (1968)

Photoconductivity Studies of Defects in Silicon: Divacancy-Associated Energy Levels—A. H. Kalma and J. C. Corelli. 173, 734 (1968)

Optical Absorption due to Inter-Conduction-Minimum Transitions in Gallium Arsenide—Ivar Balslev. 173, 762 (1968)

Photoconductivity Associated with Indium Acceptors in Silicon—J. S. Blakemore and C. E. Sarver. 173, 767 (1968)

Dielectric Singularity of α-Sn—L. Liu and David Brust. 173, 777 (1968)

Magnetoresistance of Undoped *n*-Type Gallium Arsenide at Low Temperatures—L. Halbo and R. J. Sladek. 173, 794 (1968)

Electronic Energy States of Dislocations in CdS-Type Semiconductors—R. R. Holmes and C. Elbaum. 173, 803 (1968)

Concentration Quenching of Luminescence by Donors or Acceptors in Gallium Phosphide and the Impurity-Band Auger Model—J. C. Tsang, P. J. Dean, and P. T. Landsberg. 173, 814 (1968)

Erratum: Subthreshold Electron Damage in *n*-Type Germanium—Y. Chen and J. W. MacKay. [167, 745 (1968)] 173, 918 (1968)

Free-Carrier and Exciton Recombination Radiation in GaAs—M. A. Gilleo, P. T. Bailey, and D. E. Hill. 174, 898 (1968)

Electrical and Optical Enhancement of Photoconductivity in Semi-Insulating GaAs—Jagdeep Shah and Yizhak Yacoby. 174, 932 (1968)

Energy and Orientation Dependence of Electron-Irradiation-Induced Damage in Undoped GaSb—K. Thommen. 174, 938 (1968)

Electron-Phonon Coupling in the Barriers of GaAs Schottky Diodes—P. Thomas and H. J. Queisser. 175, 983 (1968)

Stored-Energy Release in Electron-Irradiated Germanium—M. P. Singh and J. W. MacKay. 175, 985 (1968)

Toward a Theory of Isoelectronic Impurities in Semiconductors—Roger A. Faulkner. 175, 991 (1968)

Recombination Luminescence in Irradiated Silicon—Robert J. Spry and W. Dale Compton. 175, 1010 (1968)

Spin-Flip Raman Scattering in Cadmium Sulfide—D. G. Thomas and J. J. Hopfield. 175, 1020 (1968)

Effect of Ion Bombardment on the Electrical Conductivity of Germanium—William Primak and Yogeshwar Dayal. 175, 1033 (1968)

Defects in Rutile. I. Electron Paramagnetic Resonance of Interstitially Doped *n*-Type Rutile—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1091 (1968)

Defects in Rutile. II. Diffusion of Interstitial Ions—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1099 (1968)

Defects in Rutile. III. Optical and Electrical Properties of Impurities and Charge Carriers—O. W. Johnson, W. D. Ohlsen, and Paul I. Kingsbury, Jr. 175, 1102 (1968)

Calculation of Ionized-Impurity Scattering Mobility of Electrons in $Hg_{1-x}Cd_xTe$—Donald Long. 176, 923 (1968)

Electron-Capture ("Internal") Luminescence from the Oxygen Donor in Gallium Phosphide—P. J. Dean and C. H. Henry. 176, 928 (1968)

Donor-Acceptor Pair Recombination Involving the First Excited State of a Donor in GaAs—Jagdeep Shah, R. C. C. Leite, and J. P. Gordon. 176, 938 (1968)

Isoelectronic Oxygen Trap in ZnTe—J. L. Merz. 176, 961 (1968)

### 47.4 Electronic Structure and Properties (see also 44)

$\Delta_1$ Conduction-Band Minimum of Ge from High-Pressure Studies on *p-n* Junctions—A. Jayaraman, B. B. Kosicki, and J. C. Irvin. 171, 836 (1968)

Noise Properties of $n$-Type Gold-Doped Silicon—M. B. Colligan and K. M. van Vliet. 171, 881 (1968)

Nonlinear Optical Susceptibilities in Group-IV and III-V Semiconductors--Sudhanshu S. Jha and N. Bloembergen. 171, 891 (1968)

Photoelectronic Properties of ZnSe Crystals—Gerald B. Stringfellow and Richard H. Bube. 171, 903 (1968)

High-Resolution Study of the One-Electron Spectrum of Si—Luis R. Saravia and David Brust. 171, 916 (1968)

Plasma Frequency as a Test of Intervalley Transfer in the Gunn Effect—M. A. Omar. 171, 925 (1968)

Phonon-Assisted Recombination of Free Excitons in Compound Semiconductors--B. Segall and G. D. Mahan. 171, 935 (1968)

Theory of Multiphoton Magnetoabsorption in Semiconductors—Margaret H. Weiler, M. Reine, and Benjamin Lax. 171, 949 (1968)

Transverse Magnetoresistance and Hall Effect in $p$-Type Germanium—Jean W. Gallagher. 171, 987 (1968)

Erratum: Investigation of Energy-Band Structures and Electronic Properties of PbS and PbSe—Sohrab Rabii. [167, 801 (1968)] 171, 1114 (1968)

Nuclear-Magnetic-Resonance Study of Heavily Nitrogen-Doped Silicon Carbide—Michael N. Alexander. 172, 331 (1968)

$L$-Series Emission Spectrum of Germanium—Richard D. Deslattes. 172, 625 (1968)

Conduction-Band Structure of GaSb from Pressure Experiments to 50 kbar—B. B. Kosicki, A. Jayaraman, and William Paul. 172, 764 (1968)

Higher Absorption Edges in 6$H$ SiC—W. J. Choyke and Lyle Patrick. 172, 769 (1968)

Optical and Electrical Properties and Band Structure of GeTe and SnTe—R. Tsu, W. E. Howard, and L. Esaki. 172, 779 (1968)

Optical Properties of $VO_2$ between 0.25 and 5 eV—Hans W. Verleur, A. S. Barker, Jr., and C. N. Berglund. 172, 788 (1968)

Electroreflectance Studies of InAs, GaAs, and (Ga,In)As Alloys—E. W. Williams and Victor Rehn. 172, 798 (1968)

Mechanism for the Photoreflectance Effect—J. G. Gay and L. T. Klauder, Jr. 172, 811 (1968)

Polarons in Anisotropic Energy Bands—Arnold H. Kahn. 172 813 (1968)

Piezo-Electroreflectance in Ge, GaAs, and Si—Fred H. Pollak and Manuel Cardona. 172, 816 (1968)

Tuning of PbSe Lasers by Hydrostatic Pressure from 8 to 22 $\mu$—J. M. Besson, William Paul, and A. R. Calawa. 173, 699 (1968)

Electro-Optic Measurements of PbS, PbSe, and PbTe—D. E. Aspnes and M. Cardona. 173, 714 (1968)

Effects of Current Flow on the Optical Absorption of a Semiconductor—Carl A. Baumgardner and Truman O. Woodruff. 173, 746 (1968)

Optical Absorption due to Inter-Conduction-Minimum Transitions in Gallium Arsenide—Ivar Balslev. 173, 762 (1968)

Magnetoresistance in Semiconducting Strontium Titanate—O. N. Tufte and E. L. Stelzer. 173, 775 (1968)

Dielectric Singularity of $\alpha$-Sn—L. Liu and David Brust. 173, 777 (1968)

Dispersion in the Nonlinear Susceptibility of GaP near the Reststrahl Band—W. L. Faust, C. H. Henry, and R. H. Eick. 173, 781 (1968)

Electronic Energy States of Dislocations in CdS-Type Semiconductors—R. R. Holmes and C. Elbaum. 173, 803 (1968)

Concentration Quenching of Luminescence by Donors or Acceptors in Gallium Phosphide and the Impurity-Band Auger Model—J. C. Tsang, P. J. Dean, and P. T. Landsberg. 173, 814 (1968)

Optical Phonons and Dynamic Charge in Trigonal Se and Te—Inan Chen and Richard Zallen. 173, 833 (1968)

Erratum: Investigation of Energy-Band Structures and Electronic Properties of PbS and PbSe—Sohrab Rabii. [167, 801 (1968)] 173, 918 (1968)

Form Factors of Truncated Atomic Potentials—J. C. Phillips and R. Sandrock. 174, 663 (1968)

Electric-Field Modulation of Luminescence-Excitation in Natural Diamond in the Spectral Energy Range 5.0–6.0 eV—P. Denham and E. C. Lightowlers. 174, 800 (1968)

Ultraviolet Reflectivity Spectra of $CdS_{1-x}Se_x$ Single Crystals—R. L. Hengehold and C. R. Fraime. 174, 808 (1968)

Effects of a Tilted Magnetic Field on a Two-Dimensional Electron Gas—F. F. Fang and P. J. Stiles. 174, 823 (1968)

New Evidence for the Existence of Exciton Effects at Hyperbolic Critical Points—Kerry L. Shaklee, J. E. Rowe, and Manuel Cardona. 174, 828 (1968)

Excited States of Bound Exciton Complexes in CdS—D. C. Reynolds, C. W. Litton, and T. C. Collins. 174, 845 (1968)

Optical Properties of Epitaxial PbSe Films—C.-E. Blomqvist and P.-O Nilsson. 174, 849 (1968)

Urbach's Rule in an Electron-Phonon Model—Dennis Dunn. 174, 855 (1968)

Piezoresistance and Piezo-Hall Effects in $n$-ZnSe—A. Sagar, M. Pollak, and W. Lehmann. 174, 859 (1968)

Free-Carrier and Exciton Recombination Radiation in GaAs—M. A. Gilleo, P. T. Bailey, and D. E. Hill. 174, 898 (1968)

Spectral Analysis of Photoemissive Yields in GaAs and Related Crystals—Frank Herman and W. E. Spicer. 174, 906 (1968)

Location of the $L_1$ and $X_1$ Minima in GaAs as Determined by Photoemission Studies—L. W. James, R. C. Eden, J. L. Moll, and W. E. Spicer. 174, 909 (1968)

Ionic Surface States from a Band-Edge Method—Jules D. Levine and S. G. Davison. 174, 911 (1968)

Effect of a Uniform Electric Field upon the Optical Absorption of Semi-Insulating Gallium Arsenide—B. T. French. 174, 991 (1968)

Electrical Properties of $Ti_2O_3$ Single Crystals—J. M. Honig and T. B. Reed. 174, 1020 (1968)

Erratum: Electric Properties of $n$-Type Liquid Alloys of Thallium and Tellurium—Melvin Cutler and Marshall B. Field. [169, 632 (1968)] 174, 1082 (1968)

Photoemission Study of the Electronic Structure of ZnTe—J. L. Shay and W. E. Spicer. 175, 741 (1968)

Recombination Luminescence in Irradiated Silicon—Robert J. Spry and W. Dale Compton. 175, 1010 (1968)

Critical-Point Structure in Photoelectric Emission Energy Distributions—Evan O. Kane. 175, 1039 (1968)

de Haas-van Alphen Effect in $n$-Type $Bi_2Te_3$—R. B. Mallinson, J. A. Rayne, and R. W. Ure, Jr. 175, 1049 (1968)

Defects in Rutile. III. Optical and Electrical Properties of Impurities and Charge Carriers—O. W. Johnson, W. D. Ohlsen, and Paul I. Kingsbury, Jr. 175, 1102 (1968)

Erratum: Photoemission Study of the Electronic Structure of Wurtzite CdSe and CdS—J. L. Shay and W. E. Spicer. [169, 650 (1968)] 175, 1232 (1968)

Band-Structure Effects and Many-Particle Scattering Corrections in the Far-Ultraviolet Spectra of Ge and Si—David Brust and Evan O. Kane. 176, 894 (1968)

X-Ray Determination of the Electron Momentum Density in Diamond, Graphite, and Carbon Black—Richard J. Weiss and Walter C. Phillips. 176, 900 (1968)

Electroreflectance Measurements on $Mg_2Si$, $Mg_2Ge$, and $Mg_2Sn$—F. Vazquez, Richard A. Forman, and Manuel Cardona. 176, 905 (1968)

Spin Splitting and the Ultraviolet Absorption of Ge—Luis R. Saravia and David Brust. 176, 915 (1968)

Band Inversion and the Electrical Properties of $Pb_xSn_{1-x}Te$—J. R. Dixon and R. F. Bis. 176, 942 (1968)
Thermoreflectance in Semiconductors—E. Matatagui, A. G. Thompson, and Manuel Cardona. 176, 950 (1968)
Isoelectronic Oxygen Trap in ZnTe—J. L. Merz. 176, 961 (1968)
Bound-Exciton, Free-Exciton, Band-Acceptor, Donor-Acceptor, and Auger Recombination in GaAs—E. Hal Bogardus and H. Barry Bebb. 176, 993 (1968)

## 47.5 Transport Properties (see also 45)

Phonon Conductivity and Acoustic Attenuation in Si—R. P. Singh and G. S. Verma. 171, 838 (1968)
Photothermal Ionization and Photon-Induced Tunneling in the Acceptor Photoconductivity Spectrum of Semiconducting Diamond—A. T. Collins and E. C. Lightowlers. 171, 843 (1968)
Piezoresistance of $n$-Type Magnesium Stannide—L. D. Crossman and G. C. Danielson. 171, 867 (1968)
Stationary High-Field Domains in the Range of Negative Differential Conductivity in CdS Single Crystals—K. W. Böer and P. Voss. 171, 899 (1968)
Nonlinear Theory of Ultrasonic Wave Amplification and Current Saturation in Piezoelectric Semiconductors—P. K. Tien. 171, 970 (1968)
Transverse Magnetoresistance and Hall Effect in $p$-Type Germanium—Jean W. Gallagher. 171, 987 (1968)
Conduction-Band Structure of GaSb from Pressure Experiments to 50 kbar—B. B. Kosicki, A. Jayaraman, and William Paul. 172, 764 (1968)
Optical and Electrical Properties and Band Structure of GeTe and SnTe—R. Tsu, W. E. Howard, and L. Esaki. 172, 779 (1968)
Polarons in Anisotropic Energy Bands—Arnold H. Kahn. 172 813 (1968)
Photogeneration of Carriers in Vitreous Selenium—D. M. Pai and S. W. Ing, Jr. 173, 729 (1968)
Magnetic Energy Levels in an Energy Band with Inversion Asymmetry Splitting—Laura M. Roth. 173, 755 (1968)
Photoconductivity Associated with Indium Acceptors in Silicon—J. S. Blakemore and C. E. Sarver. 173, 767 (1968)
Magnetoresistance in Semiconducting Strontium Titanate—O. N. Tufte and E. L. Stelzer. 173, 775 (1968)
Magnetoresistance of Undoped $n$-Type Gallium Arsenide at Low Temperatures—L. Halbo and R. J. Sladek. 173, 794 (1968)
Acoustic Attenuation in Solids—R. Kishore. 173, 856 (1968)
Field-Controlled Photogeneration and Free-Carrier Transport in Amorphous Selenium Films—Mark D. Tabak and Peter J. Warter, Jr. 173, 899 (1968)
Piezoresistance and Piezo-Hall Effects in $n$-ZnSe—A. Sagar, M. Pollak, and W. Lehmann. 174, 859 (1968)
Low-Field Mobility and Galvanomagnetic Properties of Holes in Germanium with Phonon Scattering—P. Lawaetz. 174, 867 (1968)
Acoustoelectric Effect in Polar Semiconductors—V. V. Paranjape and S. B. Joshi. 174, 919 (1968)
Transport Properties of GaAs—J. G. Ruch and G. S. Kino. 174, 921 (1968)
Electrical and Optical Enhancement of Photoconductivity in Semi-Insulating GaAs—Jagdeep Shah and Yizhak Yacoby. 174, 932 (1968)
Electrical Properties of $Ti_2O_3$ Single Crystals—J. M. Honig and T. B. Reed. 174, 1020 (1968)
Erratum: Electron Tunneling in Metal-Semiconductor Barriers—J. W. Conley, C. B. Duke, G. D. Mahan, and J. J. Tiemann. [150, 466 (1966)] 174, 1082 (1968)
Erratum: Electric Properties of $n$-Type Liquid Alloys of Thallium and Tellurium—Melvin Cutler and Marshall B. Field. [169, 632 (1968)] 174, 1082 (1968)
Electron-Phonon Coupling in the Barriers of GaAs Schottky Diodes—P. Thomas and H. J. Queisser. 175, 983 (1968)
Effect of Ion Bombardment on the Electrical Conductivity of Germanium—William Primak and Yogeshwar Dayal. 175, 1033 (1968)
Influence of Ellipsoidal Energy Surfaces on the Differential Resistance of Schottky Barriers—R. Stratton and F. A. Padovani. 175, 1072 (1968)
Electron Mobility in CdS at High Electric Fields—K. W. Böer and K. Bogus. 176, 899 (1968)
Magnon Corrections to the Effective Mass of an Electron in a Magnetic Semiconductor—Robert M. White and Roy B. Woolsey. 176, 908 (1968)
Calculation of Ionized-Impurity Scattering Mobility of Electrons in $Hg_{1-x}Cd_xTe$—Donald Long. 176, 923 (1968)
Band Inversion and the Electrical Properties of $Pb_xSn_{1-x}Te$—J. R. Dixon and R. F. Bis. 176, 942 (1968)
Hall Measurements in Liquid Thallium-Tellurium—James M. Donally and Melvin Cutler. 176, 1003 (1968)
Erratum: Role of Longitudinal and Transverse Phonons in Lattice Thermal Conductivity of GaAs and InSb—C. M. Bhandari and G. S. Verma. [140, A2101 (1965)] 176, 1112 (1968)

## 47.6 Atoms, Nuclei, and Particles in Semiconductors (see also 20)

Assumption-Independent Single-Particle Wave Function for Positrons in Solids: Applications to Angular Distributions in Al and Si—D. Stroud and H. Ehrenreich. 171, 399 (1968)
Nuclear-Magnetic-Resonance Study of Heavily Nitrogen-Doped Silicon Carbide—Michael N. Alexander. 172, 331 (1968)
Paramagnetic-Resonance Studies of Rare-Earth Impurities in II-VI Compounds—R. K. Watts and W. C. Holton. 173, 417 (1968)
Partition of the Average Energy Deposited in Germanium as a Function of Incident Neutron Energy—Allan R. Sattler and Frederick L. Vook. 173, 435 (1968)
Meson Captures in Solids—M. Y. Au-Yang and Marvin L. Cohen. 174, 468 (1968)
Defects in Irradiated Silicon: Electron Paramagnetic Resonance and Electron-Nuclear Double Resonance of the Arsenic- and Antimony-Vacancy Pairs—Edward L. Elkin and G. D. Watkins. 174, 881 (1968)
Positron Annihilation in Semiconductors—R. Fieschi, A. Gainotti, C. Ghezzi, and M. Manfredi. 175, 383 (1968)
Channeling in Zinc-Blende Lattices: Energy-Loss Studies for Hydrogen and Helium Ions in InAs, GaSb, AlSb, and InSb—Allan R. Sattler and Frederick L. Vook. 175, 526 (1968)
Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10-180 MeV—C. D. Moak, H. O. Lutz, L. B. Bridwell, L. C. Northcliffe, and S. Datz. 176, 427 (1968)
Energy-Loss Straggling of Protons in Silicon—J. J. Kolata, T. M. Amos, and Hans Bichsel. 176, 484 (1968)

# 48 INSULATORS (see also 34 and 49)

## 48.1 Collective and Critical Effects (see also 41)

Phonon Spectrum of hcp $He^4$—V. J. Minkiewicz, T. A. Kitchens, F. P. Lipschultz, R. Nathans, and G. Shirane. 174, 267 (1968)

Observation of Pair Interaction between Ortho Molecules in Solid $H_2$—A. Brooks Harris, Larry I. Amstutz, Horst Meyer, and Samuel M. Myers. 175, 603 (1968)

Effect of Many-Body van der Waals Forces on the Lattice Dynamics of Rare-Gas Crystals—A. A. Lucas. 176, 1093 (1968)

48.2 Crystal Structure and Properties (see also 42)

Shock Compression of Argon and Xenon. IV. Conversion of Xenon to a Metal-Like State—Marvin Ross. 171, 777 (1968)

Infrared Dispersion and Lattice Vibrations of $LaF_3$—H. E. Rast, H. H. Caspers, S. A. Miller, and R. A. Buchanan. 171, 1051 (1968)

Infrared Absorption Properties of LiH, LiD Mixed Crystals —S. S. Jaswal and J. R. Hardy. 171, 1090 (1968)

Phase Diagrams of the Cuprous Halides to High Pressures —Eliezer Rapoport and Carl W. F. T. Pistorius. 172, 838 (1968)

Pressure Dependence of the Elastic Constants of Calcite—Dattatraya P. Dandekar. 172, 873 (1968)

Third-Order Elastic Constants of Calcite—H. Kaga. 172, 900 (1968)

Ground State of Solid Neon—Jean-Pierre Hansen. 172, 919 (1968)

Thermal-Expansion Measurements and Thermodynamics of Solid Krypton—D. L. Losee and R. O. Simmons. 172, 944 (1968)

Pressure Derivatives of Second-Order Elastic Constants of MgO—S. Y. La and G. R. Barsch. 172, 957 (1968)

Low-Temperature Anharmonicity in $FeCl_2$—D. P. Johnson and J. G. Dash. 172, 983 (1968)

Effect of Pressure on the Polymorphism and Melting Points of the Thallous Halides—Carl W. F. T. Pistorius and J. B. Clark. 173, 692 (1968)

Optical Phonons of Yttrium Aluminum Garnet—J. P. Hurrell, S. P. S. Porto, I. F. Chang, S. S. Mitra, and R. P. Bauman. 173, 851 (1968)

Raman Spectrum of $LaBr_3$—C. K. Asawa. 173, 869 (1968)

Isotope Effects in the Lattice Constant and Thermal Expansion of $^{20}Ne$ and $^{22}Ne$ Single Crystals—D. N. Batchelder, D. L. Losee, and R. O. Simmons. 173, 873 (1968)

Nuclear-Quadrupole-Resonance Study of Lattice Dynamics in $K_2PtCl_4$—K. R. Jeffrey and R. L. Armstrong. 174, 359 (1968)

Adjusting Poles and Zeros of Dielectric Dispersion to Fit Reststrahlen of $PrCl_3$ and $LaCl_3$—Dwight W. Berreman and Frank C. Unterwald. 174, 791 (1968)

Temperature-Dependent Vibrational Modes in Sodium Nitrite—M. K. Barnoski and J. M. Ballantyne. 174, 946 (1968)

Neutron Scattering from MgO—G. M. Borgonovi and G. W. Carriveau. 174, 953 (1968)

Measurement of Higher-Order Elastic Constants, Using Finite Deformations—B. E. Powell and M. J. Skove. 174, 977 (1968)

Pressure Dependence of Infrared Eigenfrequencies of KCl and KBr—C. Postmus, J. R. Ferraro, and S. S. Mitra. 174, 983 (1968)

Debye-Waller Factors in Rare-Gas Solids—Victor V. Goldman. 174, 1041 (1968)

Raman Spectrum of Crystalline Benzil—S. A. Solin and A. K. Ramdas. 174, 1069 (1968)

Observation of Pair Interaction between Ortho Molecules in Solid $H_2$—A. Brooks Harris, Larry I. Amstutz, Horst Meyer, and Samuel M. Myers. 175, 603 (1968)

Lattice Dynamics and Ionic Deformation in Some Alkali Halides—J. S. Melvin, J. D. Pirie, and T. Smith. 175, 1082 (1968)

Long-Wavelength Optical Lattice Vibrations in Mixed $KMgF_3$-$KNiF_3$ Crystals—A. S. Barker, Jr., J. A. Ditzenberger, and H. J. Guggenheim. 175, 1180 (1968)

Raman Scattering in $KNO_3$ Phases I, II, and III—M. Balkanski, M. K. Teng, and M. Nusimovici. 176, 1098 (1968)

48.3 Imperfections and Impurities; Amorphous Solids (see also 43)

Study of an Impurity Mode Using Specific-Heat Measurements—J. P. Harrison, P. P. Peressini, and R. O. Pohl. 171, 1037 (1968)

Application of a Modified Random-Element-Isodisplacement Model to Long-Wavelength Optic Phonons of Mixed Crystals—I. F. Chang and S. S. Mitra. 172, 924 (1968)

Equilibrium Vacancy Concentration Measurements on Solid Krypton—D. L. Losee and R. O. Simmons. 172, 934 (1968)

Optical, Electrical, and EPR Studies of KBr Crystals Doped with Cadmium—S. C. Jain and S. Radhakrishna. 172, 972 (1968)

Spin-Lattice Relaxation in Pure and Europium-Doped $BaF_2$ Crystals at High and Low Temperatures—J. R. Miller and P. P. Mahendroo. 174, 369 (1968)

Far-Infrared Properties of Lattice Resonant Modes. II. Stress Effects—I. G. Nolt and A. J. Sievers. 174, 1004 (1968)

Coulomb Interactions in an Atomic Dielectric—G. D. Mahan and R. M. Mazo. 175, 1191 (1968)

Dynamics of Disordered Harmonic Lattices. III. Normal-Mode Spectra for Abnormal Arrays—Daniel N. Payton, III, and William M. Visscher. 175, 1201 (1968)

Ionic Transport in Potassium Chloride—Robert G. Fuller, Charles L. Marquardt, Michael H. Reilly, and John C. Wells, Jr. 176, 1036 (1968)

Paraelectric-Resonance Spectroscopy—T. L. Estle. 176, 1056 (1968)

ac Dielectric Investigations of the Gyulai-Hartly Effect: Enhanced Conductivity in Alkali Halides following Plastic Deformation—M. C. Shine and R. K. MacCrone. 176, 1076 (1968)

Self-Diffusion in Solid Argon—E. H. C. Parker, H. R. Glyde, and B. L. Smith. 176, 1107 (1968)

48.4 Electronic Structure and Properties (see also 44)

Optical Third-Harmonic Generation in Dye Solutions—R. K. Chang and Lee K. Galbraith. 171, 993 (1968)

Defect Energy-Level Structure of $PbI_2$ Single Crystals—A. E. Dugan and H. K. Henisch. 171, 1047 (1968)

Infrared Dispersion and Lattice Vibrations of $LaF_3$—H. E. Rast, H. H. Caspers, S. A. Miller, and R. A. Buchanan. 171, 1051 (1968)

Second-Harmonic Light Generation in Crystals with Natural Optical Activity—H. J. Simon and N. Bloembergen. 171, 1104 (1968)

Low-Temperature Magnetic Anisotropy in $Al_2O_3:V^{3+}$—Alfred R. Smith and Raymond W. Mires. 172, 265 (1968)

Vibrational Structures Accompanying the Optic Transitions of Bound Electrons in Crystals—E. Mulazzi, G. F. Nardelli, and N. Terzi. 172, 847 (1968)

Upper and Lower Bounds for the Intermediate-Coupling Polaron Ground-State Energy—David M. Larsen. 172, 967 (1968)

Some Features of the Temperature Dependence of Infrared Absorption by Localized Vibrational Modes—A. E. Hughes. 173, 860 (1968)

Propagation of an Intense Light Beam in a Nonlinear Medium —Chen-Show Wang. 173, 908 (1968)

Multiphonon Orbit-Lattice Relaxation of Excited States of Rare-Earth Ions in Crystals—L. A. Riseberg and H. W. Moos. 174, 429 (1968)

Electric-Field-Induced Raman Scattering in $SrTiO_3$ and $KTaO_3$—P. A. Fleury and J. M. Worlock. 174, 613 (1968)

Adjusting Poles and Zeros of Dielectric Dispersion to Fit Reststrahlen of $PrCl_3$ and $LaCl_3$—Dwight W. Berreman and Frank C. Unterwald. 174, 791 (1968)

Temperature-Dependent Vibrational Modes in Sodium Nitrite—M. K. Barnoski and J. M. Ballantyne. 174, 946 (1968)

Photoconductivity in Colored Potassium Chloride—Frances H. Chapple, Gerhard Lehmann, and Allen B. Scott. 174, 1012 (1968)

Intermediate-Coupling Polaron Effective Mass—David M. Larsen. 174, 1046 (1968)

Raman Spectrum of Crystalline Benzil—S. A. Solin and A. K. Ramdas. 174, 1069 (1968)

Van Vleck Paramagnetism in Orthorhombic $TiO_2$ (Brookite)—Frank E. Senftle and Arthur N. Thorpe. 175, 1144 (1968)

Application of the Orthogonalized-Plane-Wave Method to Lithium Chloride, Sodium Chloride, and Potassium Chloride—A. Barry Kunz. 175, 1147 (1968)

Theory of Transition-Metal Complexes: Unrestricted Hartree-Fock Molecular-Orbital Method and Its Application to $KNiF_3$—D. E. Ellis, A. J. Freeman, and P. Ros. 176, 688 (1968)

## 48.5 Transport Properties (see also 45)

Experimental and Theoretical Study of the Scattering of Phonons by *U* Centers in Alkali Halide Crystals—Lee G. Radosevich and Charles T. Walker. 171, 1004 (1968)

Effect of Phonon Dispersion on Heat-Pulse Shape—J. M. Andrews, Jr., and M. W. P. Strandberg. 172, 869 (1968)

Erratum: Second-Harmonic Generation of Microwave Phonons in Quartz and Sapphire—Paul H. Carr. [169, 719 (1968)] 173, 325 (1968)

Kinetics of Oxide Film Growth on Metal Crystals: Electronic and Ionic Diffusion in Large Surface-Charge and Space-Charge Fields—A. T. Fromhold, Jr., and Earl L. Cook. 175, 877 (1968)

Theory of Heat-Pulse Propagation in a Phonon Gas—P. C. Kwok. 175, 1208 (1968)

Hypersonic Attenuation in Rutile—James N. Lange. 176, 1030 (1968)

ac Dielectric Investigations of the Gyulai-Hartly Effect: Enhanced Conductivity in Alkali Halides following Plastic Deformation—M. C. Shine and R. K. MacCrone. 176, 1076 (1968)

## 48.6 Atoms, Nuclei, and Particles in Insulators (see also 20)

Radiative and Multiphonon Relaxation of Rare-Earth Ions in $Y_2O_3$—M. J. Weber. 171, 283 (1968)

Spin Relaxation via Low-Lying Energy Level of $Fe^{2+}$ in MgO—E. L. Wilkinson, R. L. Hartman, and J. G. Castle, Jr. 171, 299 (1968)

Optical Spectrum and Zeeman Effect of $CaF_2$:$Eu^{2+}$—P. Kisliuk, H. H. Tippins, C. A. Moore, and S. A. Pollack. 171, 336 (1968)

Electron-Spin-Resonance Absorption Spectrum of Trivalent Gadolinium in Single-Crystal Calcite—S. A. Marshall and R. A. Serway. 171, 345 (1968)

Investigations of $4f \leftrightarrow 5d$ Transitions of $Ce^{+3}$ in $CaF_2$—M. Schlesinger and P. W. Whippey. 171, 361 (1968)

Interaction of Acoustic Phonons with Nuclear Spins in $KTaO_3$—E. H. Gregory. 171, 365 (1968)

Zero-Field Splitting of *S*-State Ions. III. Corrections to Parts I and II and Application to Distorted Cubic Crystals—R. R. Sharma, T. P. Das, and R. Orbach. 171, 378 (1968)

Spin-Lattice Relaxation-Time Measurements on $Er^{3+}$-Doped Lanthanum Ethylsulfate—C. R. Viswanathan and G. Kaelin. 171, 992 (1968)

Effect of Stress on the Trigonal Splittings of $d^3$ Ions in Sapphire ($\alpha$-$Al_2O_3$)—Elsa Feher and M. D. Sturge. 172, 244 (1968)

Mössbauer Measurements with $K^{40}$—P. K. Tseng, S. L. Ruby, and D. H. Vincent. 172, 249 (1968)

Nuclear Magnetic Relaxation of $F^{19}$ in Rare-Earth-Doped $LaF_3$—L. Shen. 172, 259 (1968)

Low-Temperature Magnetic Anisotropy in $Al_2O_3$:$V^{3+}$—Alfred R. Smith and Raymond W. Mires. 172, 265 (1968)

$S^{33}$ Nuclear Magnetic Resonance in Paramagnetic $\alpha$-MnS—Kenneth Lee. 172, 284 (1968)

Mössbauer Studies of the $SrTiO_3$:$Fe^{57}$ System—V. G. Bhide and H. C. Bhasin. 172, 290 (1968)

Mössbauer Effect for $Fe^{57}$ in $Al_2O_3$—Effects of Variety of Heat Treatments—V. G. Bhide and S. K. Date. 172, 345 (1968)

Low-Temperature Anharmonicity in $FeCl_2$—D. P. Johnson and J. G. Dash. 172, 983 (1968)

Stable Potential Minima and the Jahn-Teller Interaction—P. Wysling and K. A. Müller. 173, 327 (1968)

Absorption Spectrum of Optically Pumped $Al_2O_3$:$Cr^{3+}$—J. W. Huang and H. W. Moos. 173, 440 (1968)

Electron Spin Resonance of $Zn(ClO_4)_2 \cdot 6H_2O$:$Mn^{2+}$ in a Parallel and Perpendicular Configuration—I. J. Fritz and Leonard Yarmus. 173, 445 (1968)

Erratum: Theory of Magnetically Induced Electric Field Gradients in Cubic $Fe^{2+}$—U. Ganiel and S. Shtrikman. [167, 258 (1968)] 173, 630 (1968)

Nuclear-Quadrupole-Resonance Study of Lattice Dynamics in $K_2PtCl_4$—K. R. Jeffrey and R. L. Armstrong. 174, 359 (1968)

Spin-Lattice Relaxation in Pure and Europium-Doped $BaF_2$ Crystals at High and Low Temperatures—J. R. Miller and P. P. Mahendroo. 174, 369 (1968)

Nuclear and Electron Resonance Study of the Paramagnetic Cobalt Ion—Sung Ho Choh and G. S. Seidel. 174, 385 (1968)

Multiphonon Orbit-Lattice Relaxation of Excited States of Rare-Earth Ions in Crystals—L. A. Riseberg and H. W. Moos. 174, 429 (1968)

Paramagnetic-Resonance Spectra of $S^-$ Trapped in Alkali Halide Crystals—L. E. Vannotti and J. R. Morton. 174, 448 (1968)

Ground-State Modulation Using Optical Double Resonance in Trivalent Rare-Earth-Doped Single Crystals—L. Esterowitz and E. Chicklis. 174, 463 (1968)

Selection Rules for an Electronic Raman Effect in a Situation where the Appropriate Point Group is a Double Group—J. A. Koningstein. 174, 477 (1968)

Electron-Nuclear Double Resonance of the Self-Trapped Hole in LiF—Ramayana Gazzinelli and Robert Lee Mieher. 175, 395 (1968)

Electron-Nuclear Double-Resonance Spectrum of the $V_K$ Center in Sodium Fluoride—Daniel F. Daly and Robert Lee Mieher. 175, 412 (1968)

Electron-Nuclear Double-Resonance Study of the Self-Trapped Hole Associated with Lithium in NaF—Isaac L. Bass and Robert Lee Mieher. 175, 421 (1968)

Dynamic Polarization of Protons in Copper Tutton Salts (Dilute $CuK_4SO_4 \cdot 6H_2O$) and Their Spin-Lattice Relaxation Times—J. S. Karra, R. Clarkson, and T. Sato. 175, 479 (1968)

Production of Divalent Thulium in CaO and $SrCl_2$—M. M. Abraham, R. W. Reynolds, and L. A. Boatner. 175, 485 (1968)

Analysis of the Ground Term of Triply Ionized Terbium in Calcium Tungstate—D. E. Wortman. 175, 488 (1968)

**Measurement of the Nuclear Spin Diffusion Coefficient in $CaF_2$—G. W. Leppelmeier and J. Jeener. 175, 498 (1968)**
**Paramagnetic Resonance of $Cr^{3+}$ in the Layer Structure of $NaInS_2$—K. A. Müller and W. Berlinger. 175, 503 (1968)**
**Mössbauer Effect of $I^{127}$ and $Te^{125}$ in Iodine, Tellurium, and Antimony Compounds—Peter Jung and Werner Triftshäuser. 175, 512 (1968)**
Effective Density of Phonon States for $NdCl_3$ from Vibronic Spectra and Applications to Ion–Lattice Interactions—E. Cohen, L. A. Riseberg, and H. W. Moos. 175, 521 (1968)
**$4f^n \rightarrow 4f^{n-1}5d$ Spectra of Rare-Earth Ions in Crystals—Eugene Loh. 175, 533 (1968)**
**Magnetic Interactions between Rare-Earth Ions in Insulators. III. EPR Measurements of $Ce^{3+}$ Pair-Interaction Constants in $LaCl_3$—R. J. Birgeneau, M. T. Hutchings, and R. N. Rogers. 175, 1116 (1968)**
**Electron Spin Resonance of Free Radicals Formed from Group-IV and Group-V Hydrides in Inert Matrices at Low Temperature—George S. Jackel and Walter Gordy. 176, 443 (1968)**
**Matrix Perturbations of the ESR of Trapped H, N, P, and As Atoms at 4.2°K—George S. Jackel, William H. Nelson, and Walter Gordy. 176, 453 (1968)**
Spin-Lattice Coupling Constants of an $Fe^{3+}$ Ion in MgO—R. R Sharma. 176, 467 (1968)
Theoretical Study on the Anisotropy of the Spin-Lattice Relaxation for Paramagnetic Ions by MgO Crystal—Santosh Kumar, T. Ray, and D. K. Ray. 176, 489 (1968)
Modified Orbach Relaxation Process in a $La(Cl, Br)_3$ Matrix—B. A. Young and H. J. Stapleton. 176, 502 (1968)
Erratum: Magnetic Interactions between Rare-Earth Ions in Insulators. I. Accurate Electron-Paramagnetic-Resonance Determination of $Gd^{3+}$ Pair-Interaction Constants in $LaCl_3$—M. T. Hutchings, R. J. Birgeneau, and W. P. Wolf. [168, 1026 (1968)] 176, 1112 (1968)

## 48.7 Color Centers (see also 43.2)

Experimental and Theoretical Study of the Scattering of Phonons by *U* Centers in Alkali Halide Crystals—Lee G. Radosevich and Charles T. Walker. 171, 1004 (1968)
Faraday Rotation of the CaO *F* Band and 3557 Å Zero-Phonon Peak—James C. Kemp, William M. Ziniker, James A. Glaze, and Jack C. Cheng. 171, 1024 (1968)
Optical, Electron-Spin-Resonance, and Electrical Studies of Colloidal and *F*-Aggregate Centers in Highly Pure KCl Crystals. I. Colloidal Centers—S. C. Jain and G. D. Sootha. 171, 1075 (1968)
Optical, Electron-Spin-Resonance, and Electrical Studies of Colloidal and *F*-Aggregate Centers in Highly Pure KCl Crystals. II. *F*-Aggregate Centers—S. C. Jain and G. D. Sootha. 171, 1083 (1968)
Infrared Absorption Properties of LiH, LiD Mixed Crystals —S. S. Jaswal and J. R. Hardy. 171, 1090 (1968)
Conversion of $F_3^+$ Centers and Destruction of *R* Centers in LiF with *R* Light—K. L. Vander Lugt and Y. W. Kim. 171, 1096 (1968)
Optical and Electron-Spin-Resonance Studies of the $ICl^-$ $V_K$ Center in KCl:I—Lawrence S. Goldberg and Marvin L. Meistrich. 172, 877 (1968)
Magnetic Circular Dichroism of the *R* Center in KCl—William Burke. 172, 886 (1968)
Optical, Electrical, and EPR Studies of KBr Crystals Doped with Cadmium—S. C. Jain and S. Radhakrishna. 172, 972 (1968)
Luminescent Excitation Spectra of *F* and *M* Centers in KCl —James L. Boettler and W. Dale Compton. 173, 844 (1968)
Photochemical Conversion of *F* Centers to *M* Centers in KCl, KBr, and CsBr—A. D. Brothers and D. W. Lynch. 174, 958 (1968)
Electronic States of the *F* Center in Alkali Halide Crystals—W. Beall Fowler. 174, 988 (1968)
Optical Properties and Formation Kinetics of $M^+$ Centers in NaF—J. Nahum. 174, 1000 (1968)
Photoconductivity in Colored Potassium Chloride—Frances H. Chapple, Gerhard Lehmann, and Allen B. Scott. 174, 1012 (1968)
Study of the $F'$ Center in Several Alkali Halides—D. W. Lynch and D. A. Robinson. 174, 1050 (1968)
Spin Hamiltonian of Two Equivalent Nuclei: Application to the $I_2^-$ Centers—Dirk Schoemaker. 174, 1060 (1968)
Color Centers in $MgF_2$—W. A. Sibley and O. E. Facey. 174, 1076 (1968)
Data and Speculations on the Electronic Problem for the Relaxed Excited *F* Center—L. Bosi, P. Podini, and G. Spinolo. 175, 1133 (1968)
Paramagnetic $NH_3Cl$ and $NH_3Br$ Color Centers in Irradiated Ammonium Halide Single Crystals—Frank W. Patten. 175, 1216 (1968)
Additive Coloration of Alkaline-Earth Chalcogenides—Eugene B. Hensley, Wirt C. Ward, Bruce P. Johnson, and Roger L. Kroes. 175, 1227 (1968)
Additive Coloration of Calcium Oxide—Wirt C. Ward and Eugene B. Hensley. 175, 1230 (1968)
Ion-Size Effects in Color Centers—R. H. Bartram, A. M. Stoneham, and Philip Gash. 176, 1014 (1968)
ESR Studies of Radiation-Damage Centers in Barium Sulfide—James L. Kolopus and Gerald J. Lapeyre. 176, 1025 (1968)
Recombination Luminescence from Self-Trapped Excitons in Ammonium Halide Crystals—M. J. Marrone and M. N. Kabler. 176, 1070 (1968)
Effect of Optical and Thermal Bleaching on the uv Bands in Highly Pure and Mn-Doped KCl Crystals—P. C. Mehendru and Ved Mitra. 176, 1089 (1968)

# 49 MAGNETIC MATERIALS AND FERROELECTRICS (see also 41.3)

## 49.1 Collective and Critical Effects (see also 41)

Non-Closed-Shell Linear Chain: The $H_{ss}$ System—W. T. Kwo. 171, 484 (1968)
Application of the Cluster-Variation Method to the Uniaxial Antiferromagnet $FeF_2$—Tomoyasu Tanaka, Louis Libelo, and Ronald Kligman. 171, 531 (1968)
Magnetic Structures and Exchange Interactions in the Mn–Pt System—E. Krén, G. Kádár, L. Pál, J. Sólyom, P. Szabó, and T. Tarnóczi. 171, 574 (1968)
Dynamic Effects in *s-f* Antiferromagnetism—Peter A. Fedders. 172, 530 (1968)
Collective Excitations and Magnetic Ordering in Materials with Singlet Crystal-Field Ground State—Yung-Li Wang and Bernard R. Cooper. 172, 539 (1968)
Temperature Dependence of the $^{57}Fe$ hfs in the Ordered Alloys $FePd_3$ and FePd near the Curie Temperature—G. Longworth. 172, 572 (1968)
Ultrasonic Attenuation near the Critical Point of $MnF_2$—J. R. Neighbours and R. W. Moss. 173, 542 (1968)
Low-Temperature Effects of the Tunneling Integral in Hydrogen-Bonded Ferroelectrics—K. Nordtvedt, Jr. 173, 547 (1968)
Antiferromagnetism and the Magnetic Phase Diagram of $GdAlO_3$—K. W. Blazey and H. Rohrer. 173, 574 (1968)
Polar Spin Waves in Ferromagnetic Metals—J. B. Sokoloff. 173, 617 (1968)

Critical Behavior of the Pseudospin Model of Order–Disorder Type Ferroelectrics—E. Pytte and H. Thomas. 175, 610 (1968)

Magnon Density Fluctuations in the Heisenberg Ferromagnet—George F. Reiter. 175, 631 (1968)

Calculation of the Sublattice Magnetization of Yttrium Iron Garnet by the Oguchi Method—Denis F. Strenzwilk and Elmer E. Anderson. 175, 654 (1968)

Renormalization of Critical Exponents by Hidden Variables—Michael E. Fisher. 176, 257 (1968)

Theory of Anisotropic Spontaneous Magnetization and Anisotropy Energy in Orthorhombic Ferromagnets at 0°K—George T. Rado. 176, 644 (1968)

Phenomenology of Neutron Scattering in Heisenberg Systems—Herbert S. Bennett. 176, 650 (1968)

Free Energy of Interacting Magnetic Dipoles—Robert B. Griffiths. 176, 655 (1968)

Linear Chain Antiferromagnetism in $CsMnCl_3 \cdot 2H_2O$—T. Smith and S. A. Friedberg. 176, 660 (1968)

Heat Capacity of $Mn(CH_3COO)_2 \cdot 4H_2O$ between 0.4 and 20°K—J. H. Schelleng, C. A. Raquet, and S. A. Friedberg. 176, 708 (1968)

## 49.2 Crystal Structure and Properties (see also 42)

Magnetoelastic Behavior of Europium Oxide. II. Magnetostriction and the λ Anomaly—B. E. Argyle and N. Miyata. 171, 555 (1968)

Neutron Diffraction Study of the Magnetic Structure of Hematite to 41 kbar—T. G. Worlton and D. L. Decker. 171, 596 (1968)

Disappearance of a Vibrational Mode in the Ferroelectric Phase Transition of $KH_2PO_4$—Ch. Schenk, E. Wiener, B. Weckermann, and W. Kley. 172, 576 (1968)

Determination of the Nuclear Quadrupole Moment of $Fe^{57m}$ from $\alpha$-$Fe_2O_3$ Data—J. O. Artman, A. H. Muir, Jr., and H. Wiedersich. 173, 337 (1968)

Magnetic Properties of the Planar Antiferromagnet $Rb_2FeF_4$—G. K. Wertheim, H. J. Guggenheim, H. J. Levinstein, D. N. E. Buchanan, and R. C. Sherwood. 173, 614 (1968)

Elastic Moduli and Ultrasonic Attenuation of Gadolinium, Terbium, Dysprosium, Holmium, and Erbium from 4.2 to 300°K—M. Rosen. 174, 504 (1968)

Magnetic Properties of $Ga_{2-x}Fe_xO_3$—B. F. Levine, C. H. Nowlin, and R. V. Jones. 174, 571 (1968)

Determination of the Electric-Field-Gradient Tensor at the Arsenic Site in $KH_2AsO_4$ by Proton Relaxation Measurements—Wendland Beezhold and Edwin A. Uehling. 175, 624 (1968)

Antiferromagnetic Domains in $RbMnF_3$—W. J. Ince and A. Platzker. 175, 650 (1968)

Magnetic and Crystallographic Transitions in the $\alpha$-$Mn_2O_3$–$Fe_2O_3$ System—R. W. Grant, S. Geller, J. A. Cape, and G. P. Espinosa. 175, 686 (1968)

Phonons in Time-Dependent Hartree Approximation with Application to Order-Disorder Ferroelectrics—P. B. Miller and P. C. Kwok. 175, 1062 (1968)

Magnetic Scattering of Electrons from Crystals and Polarization of the Scattered Beam—Lawrence A. Vredevoe and Roger E. De Wames. 176, 684 (1968)

Magnetic Structures of $Er_2O_3$ and $Yb_2O_3$—R. M. Moon, W. C. Koehler, H. R. Child, and L. J. Raubenheimer. 176, 722 (1968)

## 49.3 Imperfections and Impurities; Alloys (see also 43)

Theory of $s$-$d$ Scattering in Dilute Magnetic Alloys with Spin-$\frac{1}{2}$ Impurities—H. J. Spencer. 171, 515 (1968)

Molecular-Field Theory for Randomly Substituted Ferrimagnetic Garnet Systems—Israel Nowik. 171, 550 (1968)

Magnetic Structures and Exchange Interactions in the Mn–Pt System—E. Krén, G. Kádár, L. Pál, J. Sólyom, P. Szabo, and T. Tarnóczi. 171, 574 (1968)

Impurity-Induced Optical Fluorescence in $MnF_2$—R. L. Greene, D. D. Sell, R. S. Feigelson, G. F. Imbusch, and H. J. Guggenheim. 171, 600 (1968)

Hyperfine Field Spectra of Binary Fe-Co Alloys: Nuclear Magnetic Resonance of $^{57}Fe$ and $^{59}Co$—Mark Rubinstein. 172, 277 (1968)

New Calculation of the Magnetic Susceptibility for the Takano-Ogawa Theory of Kondo's Effect in Dilute Alloys—A. P. Klein. 172, 520 (1968)

Temperature-Dependent Internal Field Distribution and Magnetic Susceptibility of a Dilute Ising Spin System—Michael W. Klein. 173, 552 (1968)

Kondo Problem at Low Temperatures—S. Doniach. 173, 599 (1968)

Magnetic Structure Properties of Alloys of Tb, Ho, and Er with Sc—H. R. Child and W. C. Koehler. 174, 562 (1968)

Electrical Resistivity and Screening in Some Dilute Ferromagnetic Nickel Alloys—T. Farrell. 174, 564 (1968)

Magnetoresistance of Dilute Alloys—H. Rohrer. 174, 583 (1968)

Electronic Spin Polarization around a Magnetic Impurity Using Perturbation Theory—H. U. Everts and B. N. Ganguly. 174, 594 (1968)

Application of the Cluster Variation Method to the $s$-$d$ Interaction Hamiltonian—James Halow, Tomoyasu Tanaka, and Tohru Morita. 175, 680 (1968)

Ground-State Energy of the Anderson Model by the Cluster Variation Method—Shyamalendu M. Bose and Tomoyasu Tanaka. 176, 600 (1968)

Theory of a Two-Dimensional Ising Model with Random Impurities. I. Thermodynamics—Barry M. McCoy and Tai Tsun Wu. 176, 631 (1968)

Neutron Diffraction and Susceptibility Study of Dilute La–Rare-Earth Alloys—D. K. Finnemore, L. J. Williams, F. H. Spedding, and D. C. Hopkins. 176, 712 (1968)

## 49.4 Electronic Structure and Properties (see also 44)

Spin-Orbit-Coupling Effects in Transition-Metal Compounds—John B. Goodenough. 171, 466 (1968)

Mössbauer Faraday Effect—R. M. Housley and U. Gonser. 171, 480 (1968)

Investigation of Magnetic Interactions in $TbAlO_3$ by Optical Spectroscopy—S. Hüfner, L. Holmes, F. Varsanyi, and L. G. Van Uitert. 171, 507 (1968)

Pressure and Temperature Dependence of the Dielectric Properties of the Perovskite Barium Titanate—A. K. Goswami and L. E. Cross. 171, 549 (1968)

Ferromagnetism of $CrBe_{12}$—N. M. Wolcott and R. L. Falge, Jr. 171, 591 (1968)

Impurity-Induced Optical Fluorescence in $MnF_2$—R. L. Greene, D. D. Sell, R. S. Feigelson, G. F. Imbusch, and H. J. Guggenheim. 171, 600 (1968)

Theory of Gyrotropic Birefringence—R. M. Hornreich and S. Shtrikman. 171, 1065 (1968)

Symmetry of the Wave Functions in the Band Theory of Ferromagnetic Metals—L. M. Falicov and J. Ruvalds. 172, 498 (1968)

de Haas–van Alphen Effect, Exchange Splitting, Spin-Orbit Interaction, and Magnetic Breakdown in Ferromagnetic Nickel—J. Ruvalds and L. M. Falicov. 172, 508 (1968)

Anomalous Hall Effect in Single-Crystal Dysprosium—J. J. Rhyne. 172, 523 (1968)

Magnetocrystalline Anisotropy of Europium Selenide—R. F. Brown, A. W. Lawson, and Glen E. Everett. 172, 559 (1968)
Magnetic Properties of Uranium Compounds with Elements of the VA and VIA Groups. I. Compounds of UX Type—J. Grunzweig-Genossar, M. Kuznietz, and F. Friedman. 173, 562 (1968)
Antiferromagnetism and the Magnetic Phase Diagram of $GdAlO_3$—K. W. Blazey and H. Rohrer. 173, 574 (1968)
Magnetic Properties of the Planar Antiferromagnet $Rb_2FeF_4$—G. K. Wertheim, H. J. Guggenheim, H. J. Levinstein, D. N. E. Buchanan, and R. C. Sherwood. 173, 614 (1968)
Magnetic Structure of $NaNiF_3$—A. Epstein, J. Makovsky, M. Melamud, and H. Shaked. 174, 560 (1968)
Magnetic Properties of $Ga_{2-x}Fe_xO_3$—B. F. Levine, C. H. Nowlin, and R. V. Jones. 174, 571 (1968)
Antiferromagnetic Domains in $RbMnF_3$—W. J. Ince and A. Platzker. 175, 650 (1968)
de Haas–van Alphen Effect in Antiferromagnetic Chromium—J. E. Graebner and J. A. Marcus. 175, 659 (1968)
Magnetic Properties of Gold-Rich Gold-Vanadium Alloys—L. Creveling, Jr., and H. L. Luo. 176, 614 (1968)
Specific Heat of Uranium Mononitride from 1.3 to 4.6°K—J. O. Scarbrough, H. L. Davis, W. Fulkerson, and J. O. Betterton, Jr. 176, 666 (1968)
High-Field Galvanomagnetic Effects in Antiferromagnetic Chromium—A. J. Arko, J. A. Marcus, and W. A. Reed. 176, 671 (1968)
Theory of Transition-Metal Complexes: Unrestricted Hartree-Fock Molecular-Orbital Method and Its Application to $KNiF_3$—D. E. Ellis, A. J. Freeman, and P. Ros. 176, 688 (1968)
Heat Capacity of $Mn(CH_3COO)_2 \cdot 4H_2O$ between 0.4 and 20°K—J. H. Schelleng, C. A. Raquet, and S. A. Friedberg. 176, 708 (1968)
Neutron Diffraction and Susceptibility Study of Dilute La–Rare-Earth Alloys—D. K. Finnemore, L. J. Williams, F. H. Spedding, and D. C. Hopkins. 176, 712 (1968)
Magnetic Structures of $Er_2O_3$ and $Yb_2O_3$—R. M. Moon, W. C. Koehler, H. R. Child, and L. J. Raubenheimer. 176, 722 (1968)
Transport Properties of Thulium Single Crystals—L. Roger Edwards and Sam Legvold. 176, 753 (1968)

## 49.5 Transport Properties (see also 45)

Experiments with Tunnel Junctions Using Ferromagnetic Metals—J. E. Christopher, R. V. Coleman, Acar Isin, and R. C. Morris. 172, 485 (1968)
Thermal Conductivities and Lorenz Functions of Dy, Er, and Lu Single Crystals—D. W. Boys and S. Legvold. 174, 377 (1968)
Elastic Moduli and Ultrasonic Attenuation of Gadolinium, Terbium, Dysprosium, Holmium, and Erbium from 4.2 to 300°K—M. Rosen. 174, 504 (1968)
Electrical Resistivity and Screening in Some Dilute Ferromagnetic Nickel Alloys—T. Farrell. 174, 564 (1968)
Tunneling in Ferroelectrics—J. R. Errey. 174, 568 (1968)
Diffuse and Propagating Modes in the Heisenberg Paramagnet—Herbert S. Bennett. 174, 629 (1968)
Spin Relaxation and Transport in Magnetic Alloys—Peter Fulde and Alan Luther. 175, 337 (1968)
High-Field Galvanomagnetic Effects in Antiferromagnetic Chromium—A. J. Arko, J. A. Marcus, and W. A. Reed. 176, 671 (1968)
Transport Properties of Thulium Single Crystals—L. Roger Edwards and Sam Legvold. 176, 753 (1968)
Magnon Corrections to the Effective Mass of an Electron in a Magnetic Semiconductor—Robert M. White and Roy B. Woolsey. 176, 908 (1968)

## 49.6 Atoms, Nuclei, and Particles in Magnetic Materials (see also 20)

Hyperfine Structure of $Au^{197}$ in Fe Measured with the Mössbauer Effect—R. L. Cohen. 171, 343 (1968)
Mössbauer-Effect Measurements in Iron at High Pressures—W. H. Southwell, D. L. Decker, and H. B. Vanfleet. 171, 354 (1968)
Effect of Pressure on the Isomer Shift of $Fe^{57}$ in the bcc Phase—J. A. Moyzis, Jr., and H. G. Drickamer. 171, 389 (1968)
Mössbauer Faraday Effect—R. M. Housley and U. Gonser. 171, 480 (1968)
Molecular-Field Theory for Randomly Substituted Ferrimagnetic Garnet Systems—Israel Nowik. 171, 550 (1968)
Spin Relaxation in Mössbauer Spectra of Magnetically Ordered Systems—Lionel M. Levinson and Marshall Luban. 172, 268 (1968)
Hyperfine Field Spectra of Binary Fe-Co Alloys: Nuclear Magnetic Resonance of $^{57}Fe$ and $^{59}Co$—Mark Rubinstein. 172, 277 (1968)
Influence of Radio-Frequency Magnetic Fields on the Mössbauer Effect in Magnetic $Co^{57}$ Sources—Gilbert J. Perlow. 172, 319 (1968)
Magnetically Induced Quadrupole Interactions in $FeCr_2S_4$—Gilbert R. Hoy and K. P. Singh. 172, 514 (1968)
$I^{127}$ Nuclear Quadrupole Resonance in Antiferromagnetic $UI_3$—S. I. Parks and W. G. Moulton. 173, 333 (1968)
Nuclear Spin-Wave Relaxation and Narrowing of NMR Lines in Ferro- and Antiferromagnets—Peter M. Richards. 173, 581 (1968)
Nuclear-Magnetic-Resonance Studies of $Mn^{55}$ in Ni–Mn Alloys—R. L. Streever. 173, 591 (1968)
Nuclear Properties and Magnetic Hyperfine Interaction of $Os^{189}$—B. Persson, H. Blumberg, and M. Bent. 174, 1509 (1968)
Coherent Averaging Effects in Magnetic Resonance—U. Haeberlen and J. S. Waugh. 175, 453 (1968)
Nuclear-Magnetic-Resonance Study of the Ferroelectric Transitions in $NaH_3(SeO_3)_2$ and $NaD_3(SeO_3)_2$—R. Blinc, J. Stepišnik, and I. Zupančič. 176, 732 (1968)

## 49.7 Ferro-, Ferri-, and Antiferromagnetic Resonance (see also 21)

Quadrupolar Hyperfine Anisotropy in $Fe(NH_4SO)_2 \cdot 6H_2O$ and Its Comparison with the Magnetic Susceptibility—R. Ingalls, K. Ono, and Louis Chandler. 172, 295 (1968)
Magnetocrystalline Anisotropy of Europium Selenide—R. F. Brown, A. W. Lawson, and Glen E. Everett. 172, 559 (1968)
Nuclear Spin-Wave Relaxation and Narrowing of NMR Lines in Ferro- and Antiferromagnets—Peter M. Richards. 173, 581 (1968)
Complex Susceptibility and Resonance Frequencies of Canted Antiferromagnets—F. B. Hagedorn and E. M. Gyorgy. 174, 540 (1968)
Antiferromagnetic Domains in $RbMnF_3$—W. J. Ince and A. Platzker. 175, 650 (1968)
Linear Chain Antiferromagnetism in $CsMnCl_3 \cdot 2H_2O$—T. Smith and S. A. Friedberg. 176, 660 (1968)

49.8 Ferroelectrics (see also 44.2)

Pressure and Temperature Dependence of the Dielectric Properties of the Perovskite Barium Titanate—A. K. Goswami and L. E. Cross. 171, 549 (1968)

Combinatorial Approach to the Ferroelectric Problem—R. W. Gibberd. 171, 563 (1968)

Atomic Displacement Relationship to Curie Temperature and Spontaneous Polarization in Displacive Ferroelectrics—S. C. Abrahams, S. K. Kurtz, and P. B. Jamieson. 172, 551 (1968)

Dielectric, Thermal, and Pyroelectric Properties of Ferroelectric $LiTaO_3$—A. M. Glass. 172, 564 (1968)

Disappearance of a Vibrational Mode in the Ferroelectric Phase Transition of $KH_2PO_4$—Ch. Schenk, E. Wiener, B. Weckermann, and W. Kley. 172, 576 (1968)

Low-Temperature Effects of the Tunneling Integral in Hydrogen-Bonded Ferroelectrics—K. Nordtvedt, Jr. 173, 547 (1968)

Pressure and Temperature Dependence of the Dielectric Properties of Hydrogen-Bonded Ferroelectrics: $LiH_3(SeO_3)_2$ and $LiD_3(SeO_3)_2$—G. A. Samara. 173, 605 (1968)

Erratum: Dynamical Effects of Deuteron Intrabond Jumping in $KD_2PO_4$—V. Hugo Schmidt. [164, 749 (1967)] 173, 630 (1968)

Raman Spectrum of Single-Domain $BaTiO_3$—M. DiDomenico, Jr., S. H. Wemple, S. P. S. Porto, and R. P. Bauman. 174, 522 (1968)

Tunneling in Ferroelectrics—J. R. Errey. 174, 568 (1968)

Electric-Field-Induced Raman Scattering in $SrTiO_3$ and $KTaO_3$—P. A. Fleury and J. M. Worlock. 174, 613 (1968)

Critical Behavior of the Pseudospin Model of Order–Disorder Type Ferroelectrics—E. Pytte and H. Thomas. 175, 610 (1968)

180° Domain-Wall Energies in $BaTiO_3$—W. N. Lawless. 175, 619 (1968)

Determination of the Electric-Field-Gradient Tensor at the Arsenic Site in $KH_2AsO_4$ by Proton Relaxation Measurements—Wendland Beezhold and Edwin A. Uehling. 175, 624 (1968)

Phonons in Time-Dependent Hartree Approximation with Application to Order-Disorder Ferroelectrics—P. B. Miller and P. C. Kwok. 175, 1062 (1968)

Nuclear-Magnetic-Resonance Study of the Ferroelectric Transitions in $NaH_3(SeO_3)_2$ and $NaD_3(SeO_3)_2$—R. Blinc, J. Stepišnik, and I. Zupančič. 176, 732 (1968)

Raman Scattering in $KNO_3$ Phases I, II, and III—M. Balkanski, M. K. Teng, and M. Nusimovici. 176, 1098 (1968)


# 50 NUCLEI

## 51 NUCLEAR THEORY


Nuclear-Matter Radii from a Reformulated Optical Model—G. W. Greenlees, G. J. Pyle, and Y. C. Tang. 171, 1115 (1968)

51.2 Nuclear Structure

Statistical Theory of Nuclei—K. A. Brueckner, J. R. Buchler, S. Jorna, and R. J. Lombard. 171, 1188 (1968)

Hamiltonian Operator for Velocity-Dependent Potentials—M. Razavy. 171, 1201 (1968)

Analysis of the ΛΛ Hypernucleus $_{\Lambda\Lambda}C^{14}$—S. Ali, L. P. Kok, and M. E. Grypeos. 171, 1203 (1968)

Concept of Ideal Collective Coordinate as the Foundation for a Phenomenological Theory of Nuclear Collective Motion: Basic Ideas and Relation to Other Phenomenological Methods—Abraham Klein, R. M. Dreizler, and Robert E. Johnson. 171, 1216 (1968)

Application of the Concept of Ideal Collective Coordinate to a Simple Microscopic Model—Abraham Klein and Robert E. Johnson. 171, 1224 (1968)

Angular Symmetry of the 2-Matrix—Claude Garrod. 172, 173 (1968)

Self-Consistent Theory of Nuclear Spectra: Pairing-Force Model—Giu Do Dang, R. M. Dreizler, Abraham Klein, and Chi-Shiang Wu. 172, 1022 (1968)

Antilinear Operators in Hartree-Bogolyubov Theory. I—Fedor Herbut and Milan Vujičić. 172, 1031 (1968)

Practical Method for the Treatment of Nuclear Collective Motions—Jun-Ichi Fujita. 172, 1047 (1968)

Ground State of Three Alpha Particles—J. R. Fulco and D. Y. Wong. 172, 1062 (1968)

$A^{-1/6}$ Dependence of Giant Dipole Energies—Richard Bach and Carl Werntz. 173, 958 (1968)

Success and Limitations of Two- and Four-Quasiparticle Tamm-Dancoff Theories of Vibrational States: Applications to Even Tin Isotopes with a Realistic Nucleon-Nucleon Potential—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 173, 964 (1968)

Nuclear-Matter Criterion for Semirealistic Hartree-Fock Interactions—J. M. Pearson and Gerard Saunier. 173, 991 (1968)

Isotopic-Spin Mixing in Direct and Compound-Nuclear Reactions—J. V. Noble. 173, 1034 (1968)

One-Neutron Transfer Reactions in Even and Odd Tin Isotopes and a Realistic Nucleon-Nucleon Potential—R. Alzetta and J. Sawicki. 173, 1185 (1968)

Separable $t$ Matrices and Hard-Core Potentials—Michael G. Fuda. 174, 1134 (1968)

Existence of the Trineutron—Horace Jacob and V. K. Gupta. 174, 1213 (1968)

Brueckner Theory in an Oscillator Basis. I. The Method of Reference Bethe-Goldstone Equations and Comparison of the Yale, Reid (Hard-Core), and Hamada-Johnston Interactions—Richard L. Becker, Alan D. MacKellar, and B. M. Morris. 174, 1264 (1968)

State Dependence of Coulomb Interaction in Nuclei—George F. Bertsch. 174, 1313 (1968)

Moment of Inertia in Light Nuclei—S. Das Gupta and A. Van Ginneken. 174, 1316 (1968)

Projected Tamm-Dancoff Spectra of $Ne^{20}$ and $Mg^{24}$—L. Satpathy. 174, 1324 (1968)

Structure of the Self-Consistent Solutions for Even-Even Nuclei in the $2p$-$1f$ Shell—J. C. Parikh and J. P. Svenne. 174, 1343 (1968)

Microscopic Theory of Effective Operators for Electromagnetic Interactions in Nuclei—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 175, 1243 (1968)

Short-Range Dynamical Correlations in $^6Li$ from Electron Elastic Scattering—C. Ciofi Degli Atti. 175, 1256 (1968)

Methods for Calculating Ground-State Correlations of Vibrational Nuclei—D. J. Rowe. 175, 1283 (1968)

Investigation of Ground-State Correlations for a Model Hamiltonian of the Nucleus—J. C. Parikh and D. J. Rowe. 175, 1293 (1968)

Model Dependence of Corrections to the Fermi Function and $ft$ Values of Some $0^+ \rightarrow 0^+$ Super-Allowed $\beta$ Decays, and the Value of the Vector Coupling Constant—T. A. Halpern and B. Chern. 175, 1314 (1968)

**Investigation of Nuclear Three- and Four-Body Systems with Soft-Core Nucleon-Nucleon Potentials**—I. R. Afnan and Y. C. Tang. 175, 1337 (1968)

**Binding Energies of Open-Shell Nuclei**—Maria Dworzecka and Chindhu S. Warke. 175, 1346 (1968)

**Green's Velocity-Dependent Potential in the Shell Model of $Po^{210}$, $Pb^{210}$, and $Bi^{210}$**—P. S. Ganas and Bruce H. J. McKellar. 175, 1409 (1968)

**Quantized Liquid Drop and Some Ground-State Nuclear Properties**—G. Reading Henry. 176, 1126 (1968)

**Effective Interaction for Light and Intermediate Nuclei**—K. P. Joshi, G. K. Mehta, and Y. R. Waghmare. 176, 1154 (1968)

**Comparison of Variational Results and Solutions of Faddeev Equation for a Local Potential**—I. R. Afnan and Y. C. Tang. 176, 1232 (1968)

**Symmetric-Core Collective Model for Odd-Odd Nuclei with Applications in the 2*s*-1*d* Shell**—R. J. Ascuitto, D. A. Bell, and J. P. Davidson. 176, 1323 (1968)

**Dipole States in $Sr^{88}$**—B. Goulard, T. A. Hughes, and S. Fallieros. 176, 1345 (1968)

**Level Spectra of Odd Isotopes of Ga, As, Br, and Rb in the Coriolis Coupling Model with a Residual Interaction of the Pairing Type**—W. Scholz and F. B. Malik. 176, 1355 (1968)

## 51.4 Nuclear Matter (see also 31)

**Nuclear-Matter Criterion for Semirealistic Hartree-Fock Interactions**—J. M. Pearson and Gerard Saunier. 173, 991 (1968)

**Nuclear Forces**—Lester Ingber. 174, 1250 (1968)

**Relative Proton Number in Neutron Star Matter**—J. Nemeth and Donald W. L. Sprung. 176, 1496 (1968)

## 51.6 Nuclear Reactions and Scattering (see also 65)

**Polarization Effects in $(d,p)$ Reactions According to the Butler-Hewitt-McKellar-May Theory**—Bruce H. J. McKellar. 171, 1137 (1968)

**Model-Independent Analysis of Inelastic Electron Scattering from Nuclei. I. Monopole and Quadrupole Excitations at Low Momentum Transfer**—Thomas H. Schucan. 171, 1142 (1968)

**Influence of Breakup Channels in Elastic Scattering of Composite Particles**—P. M. Fishbane and J. V. Noble. 171, 1150 (1968)

**Resonance Widths and Spacings: Their Averages and Distributions**—P. A. Moldauer. 171, 1164 (1968)

**Off-Energy-Shell *t*-Matrix Elements for Local Potentials Containing Hard Cores**—Robert Laughlin and Bruce L. Scott. 171, 1196 (1968)

**$(d,p)$ Spectroscopic Factors from the Butler-Born Approximation**—D. C. Peaslee. 171, 1208 (1968)

**General Formulas for Describing the Absorption of Polarized Photons by Oriented Nuclei**—Hartmuth Arenhövel. 171, 1212 (1968)

**Velocity-Dependent Potential Parametrization for $^1S_0$ Elastic Proton-Proton Scattering**—John E. Brolley. 171, 1439 (1968)

**High-Energy Hadron-Nucleus Collisions. I. Protons**—Alfred S. Goldhaber and Charles J. Joachain. 171, 1566 (1968)

**Emission of Low-Energy Photons in Scattering and Decay Processes and a Possible Method for Determining Electromagnetic Properties of Short-Lived States**—Saul Barshay and Tsu Yao. 171, 1708 (1968)

**Soft-Core Hamada-Johnston Nucleon-Nucleon Potential**—E. Rochleder and K. Erkelenz. 172, 1013 (1968)

**The $C^{12}[He^3, Be^8(g.s.)]Be^8(g.s.)$ Reaction**—K. S. Jayaraman and H. D. Holmgren. 172, 1015 (1968)

**Ground State of Three Alpha Particles**—J. R. Fulco and D. Y. Wong. 172, 1062 (1968)

**Erratum: Generalized Hartree-Fock Approximation for Nucleon-Nucleon Scattering**—Louis Celenza. [168, 1189 (1968)] 172, 1282 (1968)

**Zero-Parameter Model of the *N*-*N* Potential**—Hirotaka Sugawara and Frank von Hippel. 172, 1764 (1968)

**Faddeev Equations for Atomic Problems and Solutions for the ($e^-$, H) System**—James S. Ball, Joseph C. Y. Chen, and David Y. Wong. 173, 202 (1968)

**New Theoretical Approach to Nuclear Heavy-Ion Scattering**—Keith A. Brueckner, J. Robert Buchler, and Michael M. Kelly. 173, 944 (1968)

**Overlapping Compound-Nucleus Resonances**—Nazakat Ullah. 173, 971 (1968)

**Neutron Spectroscopic Factors from Isobaric Analog States**—W. J. Thompson, J. L. Adams, and D. Robson. 173, 975 (1968)

**Isotopic-Spin Mixing in Direct and Compound-Nuclear Reactions**—J. V. Noble. 173, 1034 (1968)

**Extended *R*-Matrix Theory of Nuclear Reactions**—L. Garside and W. Tobocman. 173, 1047 (1968)

**Statistical Model for High-Energy Reactions**—L. L. Foldy, H. Kottler, D. R. Speiser, and J. Weyers. 173, 1517 (1968)

**Extracting the Phase of Scattering Amplitudes by Means of the Glauber Formula**—J. C. Vander Velde. 173, 1544 (1968)

**High-Energy Multiple Scattering for Large Angles**—D. K. Ross. 173, 1695 (1968)

**Shape of the Nuclear Symmetry Potential**—J. Zimányi and B. Gyarmati. 174, 1112 (1968)

**Calculation of the Lifetime of a Metastable System**—L. Celenza and W. Tobocman. 174, 1115 (1968)

**Low-Energy Method in High-Energy Scatterings**—Yukap Hahn. 174, 1135 (1968)

**Theoretical Calculations of Statistical Heavy-Ion Reactions**—E. Gadioli, I. Iori, and L. Zetta. 174, 1140 (1968)

**Many-Body Theory of Nuclear Reactions**—Yukap Hahn. 174, 1168 (1968)

**High-Energy Proton Scattering and the Structure of Light Nuclei**—Robert H. Bassel and Colin Wilkin. 174, 1179 (1968)

**Single Separable Potential with Attraction and Repulsion**—Frank Tabakin. 174, 1208 (1968)

**Intermediate Structure and Particle-Hole States in Nuclear Reactions**—G. L. Payne. 174, 1227 (1968)

**Realistic *N*-*N* One-Boson-Exchange Potentials**—T. Ueda and A. E. S. Green. 174, 1304 (1968)

**Influence of Angular Momentum on the Decay of the $Ni^{60}$ Compound Nucleus**—J. Benveniste, G. Merkel, and A. Mitchell. 174, 1357 (1968)

**Comparison of Experiment and Theory for Nuclear Excitation in $^{115}In$ by Threshold-Energy Electrons**—B. T. Chertok and W. T. K. Johnson. 174, 1525 (1968)

**Optimized Polynomial Expansion for Scattering Amplitudes**—R. E. Cutkosky and B. B. Deo. 174, 1859 (1968)

**Many-Level Formula for Scattering from Extremely Strong Square Potentials**—S. Tani. 174, 2054 (1968)

**Separable-Potential Fits to Nucleon-Nucleon Scattering Data**—Thomas R. Mongan. 175, 1260 (1968)

**Gell-Mann–Goldberger Relation for Reactions of the Form $(d,pn)$**—C. M. Vincent. 175, 1309 (1968)

Shell Model in the Continuum—Application to the Four-Nucleon System—Jörg Hüfner and C. M. Shakin. 175, 1350 (1968)
Static Coulomb Corrections to the Point-Nucleus Fermi Function in Nuclear Beta Decay—L. J. Logue and B. Chern. 175, 1367 (1968)
High-Energy Nucleus-Nucleus Collisions. I. General Theory and Applications to Deuteron-Deuteron Scattering—Victor Franco. 175, 1376 (1968)
Use of a Truncated Hilbert Space in Nuclear Reaction Calculations—Jörg Hüfner and R. H. Lemmer. 175, 1394 (1968)
Scattering of Medium-Energy Alpha Particles. I. Phenomenological Analysis of Elastic Scattering—Daphne F. Jackson and C. G. Morgan. 175, 1402 (1968)
11-MeV Proton Optical-Model Analysis—C. M. Perey, F. G. Perey, J. K. Dickens, and R. J. Silva. 175, 1460 (1968)
Regge-Type Representations for Coulomb-Nuclear $S$ Matrix—C. S. Shastry and R. K. Satpathy. 175, 1544 (1968)
Low-Energy Properties of Realistic $N$-$N$ One-Boson-Exchange Potentials—Alexander Gersten and A. E. S. Green. 176, 1199 (1968)
Effects of Using a Velocity-Dependent Potential in a Monte Carlo Simulation of Intranuclear Cascades—K. Chen, G. Friedlander, and J. M. Miller. 176, 1208 (1968)
Coupled-Channel Calculation of $C^{12}$-Neutron Scattering—J. T. Reynolds, C. J. Slavik, C. R. Lubitz, and N. C. Francis. 176, 1213 (1968)
Study of $He^3$+$He^4$ and $H^3$+$He^4$ Systems with the Resonating-Group Method—Ronald E. Brown and Y. C. Tang. 176, 1235 (1968)
Analysis of Nuclear Scattering by Regge Poles—R. Shanta and C. S. Shastry. 176, 1254 (1968)
$g_{7/2}$-$h_{11/2}$ Anomaly in Stripping Studies near $A$=110—B. L. Cohen, R. A. Moyer, J. B. Moorhead, L. H. Goldman, and R. C. Diehl. 176, 1401 (1968)
Nuclear Effects on the Quasi-Elastic Neutrino Scattering $\nu+n \rightarrow \mu^-+p$—York-Peng Yao. 176, 1680 (1968)
High-Energy Scattering by Nuclei—Edward A. Remler. 176 2108 (1968)

## 52 NUCLEI WITH $A \leq 5$

### 52.1 Properties; Mass, Abundance, Moments, and Spin (see also 11.4 and 21.4)

Existence of the Trineutron—Horace Jacob and V. K. Gupta. 174, 1213 (1968)
$\pi^-$-$^4$He Inelastic and Capture Reactions Leading to Excited and Multineutron Final States—Leon Kaufman, Victor Perez-Mendez, and John Sperinde. 175, 1358 (1968)

### 52.2 Spectroscopy; Decay, Energy Levels, and Transitions

$\pi^-$-$^4$He Inelastic and Capture Reactions Leading to Excited and Multineutron Final States—Leon Kaufman, Victor Perez-Mendez, and John Sperinde. 175, 1358 (1968)
Search for States in the Three-Neutron and Triton Systems—Gerald G. Ohlsen, Richard H. Stokes, and P. G. Young. 176, 1163 (1968)
Search for Unbound States in $He^3$ through $Li^6(p,\alpha)$—David K. Olsen and Ronald E. Brown. 176, 1192 (1968)
Study of $He^3$+$He^4$ and $H^3$+$He^4$ Systems with the Resonating-Group Method—Ronald E. Brown and Y. C. Tang. 176, 1235 (1968)

### 52.3 Nuclear Reactions and Scattering—of Photons

Electromagnetic Interactions of Loosely-Bound Composite Systems—Stanley J. Brodsky and Joel R. Primack. 174, 2071 (1968)
Shell Model in the Continuum—Application to the Four-Nucleon System—Jörg Hüfner and C. M. Shakin. 175, 1350 (1968)

### 52.4 —— of Leptons

Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Erratum: Threshold Electrodisintegration of the Deuteron—Ronald J. Adler. [169, 1192 (1968)] 174, 2169 (1968)

### 52.5 —— of Mesons and Hyperons

Regge-Pole Formalism for Pionic Disintegration of Deuteron—Huan Lee. 174, 2130 (1968)
Isospin and $U$-Spin Dependence of Hadron-Nucleon Total Cross Sections—Harry J. Lipkin. 174, 2151 (1968)
$\Lambda$-$\Sigma$ Conversion and $\Lambda n p$ Isospin-Zero Bound States—Alan J. Toepfer and L. H. Schick. 175, 1253 (1968)
$\pi^-$-$^4$He Inelastic and Capture Reactions Leading to Excited and Multineutron Final States—Leon Kaufman, Victor Perez-Mendez, and John Sperinde. 175, 1358 (1968)

### 52.6 —— of Nucleons

Angular Distribution of the $d(p,n)2p$ Reaction at 45.5 MeV—Demetrius J. Margaziotis, Byron T. Wright, and W. T. H. van Oers. 171, 1170 (1968)
Measurements of $C_{NN}$ in Proton-Proton Scattering from 305 to 415 MeV—A. Beretvas. 171, 1392 (1968)
Determination of the Nucleon-Nucleon Scattering Matrix. IX. $(n,p)$ Analysis from 7 to 750 MeV—Malcolm H. MacGregor, Richard A. Arndt, and Robert M. Wright. 173, 1272 (1968)
Elastic Scattering of 14-MeV Neutrons by Deuterons—A. C. Berick, R. A. J. Riddle, and C. M. York. 174, 1105 (1968)
Proton-Proton Elastic Scattering between 6 and 10 MeV—R. J. Slobodrian, H. E. Conzett, E. Shield, and W. F. Tivol. 174, 1122 (1968)
High-Energy Proton Scattering and the Structure of Light Nuclei—Robert H. Bassel and Colin Wilkin. 174, 1179 (1968)
Realistic $N$-$N$ One-Boson-Exchange Potentials—T. Ueda and A. E. S. Green. 174, 1304 (1968)
Weak Parity-Nonconserving Potentials—D. Tadić. 174, 1694 (1968)
Shell Model in the Continuum—Application to the Four-Nucleon System—Jörg Hüfner and C. M. Shakin. 175, 1350 (1968)
Proton-Neutron Triple Scattering at 425 MeV. I.—S. C. Wright, D. Shawhan, L. Pondrom, S. Olsen, and R. Handler. 175, 1704 (1968)
Pion Production in the Proton-Deuteron Interaction—P. K. Patnaik. 175, 2069 (1968)
Proton-Proton Bremsstrahlung at 47 MeV—D. L. Mason, M. L. Halbert, and L. C. Northcliffe. 176, 1159 (1968)
High-Energy Scattering at Moderately Large Angles—L. I. Schiff. 176, 1390 (1968)

Nucleon-Nucleon Models, Charge Splitting, and the Nucleon-Nucleon Data near 210 MeV—M. D. Miller, P. S. Signell, and N. R. Yoder. 176, 1724 (1968)

Three-Body Interaction Effects in High-Energy Scattering from Deuterons—David R. Harrington. 176, 1982 (1968)

52.7 —— of Deuterons and Tritons

Influence of Breakup Channels in Elastic Scattering of Composite Particles—P. M. Fishbane and J. V. Noble. 171, 1150 (1968)

Search for the Ground State of $^5$H by means of the $^3$H($t$,$p$) Reaction—P. G. Young, Richard H. Stokes, and Gerald G. Ohlsen. 173, 949 (1968)

Parity Conservation in the Reaction T($d$,$n$)He$^4$—D. C. Bonar, C. W. Drake, R. D. Headrick, and V. W. Hughes. 174, 1200 (1968)

High-Energy Nucleus-Nucleus Collisions. I. General Theory and Applications to Deuteron-Deuteron Scattering—Victor Franco. 175, 1376 (1968)

Search for States in the Three-Neutron and Triton Systems—Gerald G. Ohlsen, Richard H. Stokes, and P. G. Young. 176, 1163 (1968)

52.8 —— of He$^3$ and He$^4$($\alpha$)

Reaction T($^3$He,$\gamma$)$^6$Li in the Energy Range 0.5-11 MeV—S. L. Blatt, A. M. Young, S. C. Ling, K. J. Moon, and C. D. Porterfield. 176, 1147 (1968)

Study of He$^3$+He$^4$ and H$^3$+He$^4$ Systems with the Resonating-Group Method—Ronald E. Brown and Y. C. Tang. 176, 1235 (1968)

53 NUCLEI WITH $6 \leq A \leq 19$

53.1 Properties; Mass, Abundance, Moments, and Spin (see also 11.4 and 21.4)

Carbon-10 and Mass Measurements for Light Nuclei—H. Brunnader, J. C. Hardy, and Joseph Cerny. 174, 1247 (1968)

Atomic Hyperfine Structure. I. Polarization Wave Functions for the Ground States of B, C, N, O, and F.—Henry F. Schaefer III, Richard A. Klemm, and Frank E. Harris. 176, 49 (1968)

53.2 Spectroscopy; Decay, Energy Levels, and Transitions

$E2$ and $M1$ Matrix Elements in B$^{10}$—E. K. Warburton, J. W. Olness, S. D. Bloom, and A. R. Poletti. 171, 1178 (1968)

Magnetic Dipole Transitions and Isospin in Be$^8$—P. Paul, D. Kohler, and K. A. Snover. 173, 919 (1968)

Gamma-Ray Decay of the 6.92-, 7.12-, 8.88-, and 13.10-MeV States in O$^{16}$—D. H. Wilkinson, D. E. Alburger, and J. Lowe. 173, 995 (1968)

State Dependence of Coulomb Interaction in Nuclei—George F. Bertsch. 174, 1313 (1968)

Beta Decay of N$^{16}$ to the 6.05-MeV State of O$^{16}$—E. K. Warburton, W. R. Harris, and D. E. Alburger. 175, 1275 (1968)

Observation of the Lowest $p$-Shell $T=\frac{3}{2}$ States of $^{11}$B and $^{11}$C—S. W. Cosper, Robert L. McGrath, Joseph Cerny, Creve C. Maples, George W. Goth, and Donald G. Fleming. 176, 1113 (1968)

Gamma Decays from the First $T=\frac{1}{2}$ Levels in $^{13}$N and $^{13}$C—C. L. Cocke, J. C. Adloff, and P. Chevallier. 176, 1120 (1968)

Lifetimes of Levels in $A$=10 Nuclei—T. R. Fisher, S. S. Hanna, D. C. Healey, and P. Paul. 176, 1130 (1968)

Lifetimes of Levels in $^{12}$C, $^{13}$C, and $^{13}$N—F. Riess, P. Paul, J. B. Thomas, and S. S. Hanna. 176, 1140 (1968)

Nonexistence of the 14.6-MeV State in Be$^7$—P. D. Parker, D. W. Mingay, and J. C. Overley. 176, 1211 (1968)

53.3 Nuclear Reactions and Scattering — of Photons

Second Born Corrections to Wide-Angle High-Energy Electron Pair Production and Bremsstrahlung—Stanley J. Brodsky and John R. Gillespie. 173, 1011 (1968)

Muon-Capture and Photon-Absorption Calculations in a Configuration-Mixing Model for O$^{16}$—G. E. Walker. 174, 1290 (1968)

Fast-Photoneutron Spectra due to 55–85-MeV Photons—N. N. Kaushal, E. J. Winhold, P. F. Yergin, H. A. Medicus, and R. H. Augustson. 175, 1330 (1968)

C$^{12}$($\gamma$,$p$)B$^{11}$ Angular Distributions In and Just Above the Giant Resonance—David E. Frederick and A. Daniel Sherick. 176, 1177 (1968)

53.4 —— of Leptons, Mesons, and Hyperons

Analysis of the $\Lambda\Lambda$ Hypernucleus $_{\Lambda\Lambda}$C$^{14}$—S. Ali, L. P. Kok, and M. E. Grypeos. 171, 1203 (1968)

Comparison of Calculated Radiochemical Cross Sections with Experimental Results for Incident Protons and $\pi^-$ Mesons in the 50- to 400-MeV Region: Effect of Varying a Few Nuclear Parameters in the Calculations—Hugo W. Bertini. 171, 1261 (1968)

Optical-Model Analysis of Pion-Nucleus Scattering. II. Pion Form Factor—E. H. Auerbach, D. M. Fleming, and M. M. Sternheim. 171, 1781 (1968)

Charge-Exchange Scattering of $K^+$ Mesons from Beryllium at 0.97 BeV/$c$—J. Gezelter, G. L. Salmon, F. V. Murphy, G. K. O'Neill, and R. Grismore. 173, 1315 (1968)

Double Charge Exchange of Positive $\pi$ Mesons on Complex Nuclei—P. E. Boynton, Thomas J. Devlin, J. Solomon, and V. Perez-Mendez. 174, 1083 (1968)

Single-Proton Emission Following Positive Pion Absorption in Carbon—T. R. Witten, M. Blecher, and K. Gotow. 174, 1166 (1968)

Pion Double-Charge-Exchange Cross-Section Measurements—C. J. Cook, M. E. Nordberg, Jr., and R. L. Burman. 174, 1374 (1968)

Electroexcitation of the Giant Resonance in $^{12}$C—Francis J. Kelly and H. Überall. 175, 1235 (1968)

Short-Range Dynamical Correlations in $^6$Li from Electron Elastic Scattering—C. Ciofi Degli Atti. 175, 1256 (1968)

53.5 —— of Protons

Elastic Scattering of 1- to 2.7-MeV Protons by C$^{14}$—W. R. Harris and J. C. Armstrong. 171, 1230 (1968)

Comparison of Calculated Radiochemical Cross Sections with Experimental Results for Incident Protons and $\pi^-$ Mesons in the 50- to 400-MeV Region: Effect of Varying a Few Nuclear Parameters in the Calculations—Hugo W. Bertini. 171, 1261 (1968)

Capture and Elastic Scattering of Protons by $^{14}$C—Jerry D. Henderson, Emmett L. Hudspeth, and William R. Smith. 172, 1058 (1968)

Polarization in $^{12}$C($p$,$p$)$^{12}$C—G. E. Terrell, M. F. Jahns, M. R. Kostoff, and E. M. Bernstein. 173, 931 (1968)

$^{13}$N Levels from $^{12}$C($p$,$p$)$^{12}$C—E. M. Bernstein and G. E. Terrell. 173, 937 (1968)

Analysis of the C$^{12}$($p$,$\alpha$)B$^9$ Reaction at 44.5 MeV—T. Y. Li and B. Hird. 174, 1130 (1968)

High-Energy Proton Scattering and the Structure of Light Nuclei—Robert H. Bassel and Colin Wilkin. 174, 1179 (1968)

Proton and Neutron Resonances in Nitrogen—F. Borelli, P. N. Shrivastava, B. B. Kinsey, and V. C. Mistry. 174, 1221 (1968)

Observation of the Lowest $p$-Shell $T=\frac{1}{2}$ States of $^{11}$B and $^{11}$C—S. W. Cosper, Robert L. McGrath, Joseph Cerny, Creve C. Maples, George W. Goth, and Donald G. Fleming. 176, 1113 (1968)
Search for Unbound States in $He^3$ through $Li^6(p,\alpha)$—David K. Olsen and Ronald E. Brown. 176, 1192 (1968)
Nonexistence of the 14.6-MeV State in $Be^7$—P. D. Parker, D. W. Mingay, and J. C. Overley. 176, 1211 (1968)
$^6Li(p,p)^6Li$(3.56 MeV) Reaction from $E_p$=24.3 to 46.4 MeV and the Effective Interaction—S. M. Austin, P. J. Locard, W. Benenson, and G. M. Crawley. 176, 1227 (1968)
$Be^9(p,p\alpha)He^5$ Reaction at 57 MeV—P. G. Roos, H. G. Pugh, Mahavir Jain, H. D. Holmgren, Martin Epstein, and C. A. Ludemann. 176, 1246 (1968)

53.6 —— of Neutrons

Neutron Cross-Section Measurements of $^{12}$C between 14 and 25 MeV—F. Boreli, B. B. Kinsey, and P. N. Shrivastava. 174, 1147 (1968)
Single Separable Potential with Attraction and Repulsion—Frank Tabakin. 174, 1208 (1968)
Proton and Neutron Resonances in Nitrogen—F. Boreli, P. N. Shrivastava, B. B. Kinsey, and V. C. Mistry. 174, 1221 (1968)
Use of a Truncated Hilbert Space in Nuclear Reaction Calculations—Jörg Hüfner and R. H. Lemmer. 175, 1394 (1968)
Coupled-Channel Calculation of $C^{12}$-Neutron Scattering—J. T. Reynolds, C. J. Slavik, C. R. Lubitz, and N. C. Francis. 176, 1213 (1968)

53.7 —— of Deuterons and Tritons

Polarization of the Neutrons from the $^{12}C(d,n)^{13}N$ Reaction at the 4-MeV Resonance and between 5.2 and 6.2 MeV—T. R. Donoghue, W. L. Baker, P. L. Beach, D. C. DeMartini, and C. R. Soltesz. 173, 952 (1968)
Semidirect $T$-Forbidden Reaction $^{12}C(d,\alpha)^{10}B_6^*$, $T=1$—J. Jänecke, T. F. Yang, R. M. Polichar, and W. S. Gray. 175, 1301 (1968)

53.8 —— of $He^3$ and $He^4(\alpha)$

$E2$ and $M1$ Matrix Elements in $B^{10}$—E. K. Warburton, J. W. Olness, S. D. Bloom, and A. R. Poletti. 171, 1178 (1968)
The $C^{13}[He^3,Be^9$(g.s.)$]Be^9$(g.s.) Reaction—K. S. Jayaraman and H. D. Holmgren. 172, 1015 (1968)
Elastic and Inelastic Scattering of $^3$He by $^{12}$C, 12.0-18.0 MeV—H. T. Fortune, T. J. Gray, W. Trost, and N. R. Fletcher. 173, 1002 (1968)
$N^{14}(\alpha,\gamma)F^{18}$ Reaction—P. D. Parker. 173, 1021 (1968)
$^{16}O(\alpha,2\alpha)^{12}C_{g.s.}$ Reaction Mechanisms near 25 MeV—A. W. Parker, J. S. Allen, R. L. Yerke, and V. G. Stotland. 174, 1093 (1968)
Determination of the Neutron Polarization from the $^{13}C(^3He,n)^{15}O_{g.s.}$ Reaction from 2.9 to 3.9 MeV—Th. Stammbach, R. S. Thomason, J. Taylor, Jr., and R. L. Walter. 174, 1119 (1968)
Study of the Two-Body Force through the $(He^3,t)$ Charge-Exchange Reaction on $O^{17}$ and $O^{18}$—Luisa F. Hansen, Marion L. Stelts, Jose G. Vidal, J. J. Wesolowski, and V. A. Madsen. 174, 1155 (1968)
Gamma Decays from the First $T=\frac{1}{2}$ Levels in $^{13}$N and $^{13}$C—C. L. Cocke, J. C. Adloff, and P. Chevallier. 176, 1120 (1968)
Analysis of Nuclear Scattering by Regge Poles—R. Shanta and C. S. Shastry. 176, 1254 (1968)

53.9 —— of Heavy Nuclei

Sequential Reactions from $Li^6$ on $Be^9$—Ramanathan Jambunathan and Russell K. Hobbie. 172, 1065 (1968)
New Theoretical Approach to Nuclear Heavy-Ion Scattering—Keith A. Brueckner, J. Robert Buchler, and Michael M. Kelly. 173, 944 (1968)
Theoretical Calculations of Statistical Heavy-Ion Reactions—E. Gadioli, I. Iori, and L. Zetta. 174, 1140 (1968)
Alpha-Particle Yields and Angular Distributions in the $O^{16}(Li^6,\alpha_0)F^{18}$ Reaction from 4.8 to 13.8 MeV—M. Wayne Greene. 176, 1204 (1968)

54 NUCLEI WITH $20 \leq A \leq 89$

54.1 Properties; Mass, Abundance, Moments, and Spin (see also 11.4 and 21.4)

Mössbauer Measurements with $K^{40}$—P. K. Tseng, S. L. Ruby, and D. H. Vincent. 172, 249 (1968)
Determination of the Nuclear Quadrupole Moment of $Fe^{57m}$ from $\alpha$-$Fe_2O_3$ Data—J. O. Artman, A. H. Muir, Jr., and H. Wiedersich. 173, 337 (1968)
Precise Muonic K$\alpha$ Isotope Shifts for Nuclides from Si to Sn—R. D. Ehrlich. 173, 1088 (1968)
Determination of $g$-Factor Ratios for Free $Rb^{85}$ and $Rb^{87}$ Atoms—C. W. White, W. M. Hughes, G. S. Hayne, and H. G. Robinson. 174, 23 (1968)
Coulomb-Recoil-Implantation Mössbauer Experiments with $^{73}$Ge—Gordon Czjzek, J. L. C. Ford, Jr., John C. Love, Felix E. Obenshain, and Horst H. F. Wegener. 174, 331 (1968)
Hyperfine Structure of $^{67}$Ga and $^{72}$Ga—Vernon J. Ehlers, Yurdanur Kabasakal, Howard A. Shugart, and Orhan Tezer. 176, 25 (1968)
Symmetric-Core Collective Model for Odd-Odd Nuclei with Applications in the $2s$-$1d$ Shell—R. J. Ascuitto, D. A. Bell, and J. P. Davidson. 176, 1323 (1968)

54.2 Spectroscopy; Decay, Energy Levels, and Transitions

Inelastic Electron Scattering from $^{24}$Mg at 180°—L. W. Fagg, W. L. Bendel, R. A. Tobin, and H. F. Kaiser. 171, 1250 (1968)
Nuclear Resonance Fluorescence in $Cu^{65}$—F. R. Metzger. 171, 1257 (1968)
Lifetimes, Energies, and Branching Ratios of $^{28}$Si Excited States—E. F. Gibson, K. Battleson, and D. K. McDaniels. 172, 1004 (1968)
Two-Particle, Two-Hole States in $^{40}$K from the Study of the $^{40}Ar(^3He,^3H)^{40}K$ Reaction—J. J. Wesolowski, Luisa F. Hansen, and M. L. Stelts. 172, 1072 (1968)
Precise Energies of $^{40}$Ca Levels—E. Kashy and J. L. Snelgrove. 172, 1124 (1968)
Nuclear-Reaction Studies in the Strontium Isotopes: Neutron Particle-Hole States in $Sr^{88}$ and the $Sr^{87}(d,p)Sr^{88}$ Reaction—E. R. Cosman and D. C. Slater. 172, 1126 (1968)
Energy Levels in $^{89}$Y—P. F. Hinrichsen, S. M. Shafroth, and D. M. Van Patter. 172, 1134 (1968)
Nuclear Structure of $Na^{23}$. V. Doppler-Shift Attenuation Measurements—P. Paul, J. W. Olness, and E. K. Warburton. 173, 1063 (1968)
Intensities of Inner Beta Groups in $Ca^{47}$ and Shapes of Nonstatistical Allowed Outer Groups in $Ca^{47}$ and $P^{32}$—H. J. Fischbeck. 173, 1078 (1968)
First Excited State of $^{35}$S—L. K. ter Veld and Th. W. van der Mark. 173, 1101 (1968)

State Dependence of Coulomb Interaction in Nuclei—George F. Bertsch. 174, 1313 (1968)

Gamma-Ray Widths of the 3.00-MeV Level of $Al^{27}$ and the 3.13-MeV Level of $P^{31}$—S. W. Robinson, C. P. Swann, and V. K. Rasmussen. 174, 1320 (1968)

Projected Tamm-Dancoff Spectra of $Ne^{20}$ and $Mg^{24}$—L. Satpathy. 174, 1324 (1968)

Evidence for a 0+ State in $^{62}$Zn Populated by $^{62}$Ga—H. K. Carter, J. H. Hamilton, A. V. Ramayya, and J. J. Pinajian. 174, 1329 (1968)

Spins of Levels in $^{33}$P—C. E. Moss, R. V. Poore, N. R. Roberson, and D. R. Tilley. 174, 1333 (1968)

Gamma Decay of $T=\frac{1}{2}$ States in $Al^{25}$ and $P^{29}$—G. C. Morrison, D. H. Youngblood, R. C. Bearse, and R. E. Segel. 174, 1366 (1968)

Positron Decays of $^{38}$Ca and $^{38}$K—R. W. Kavanagh, A. Gallmann, E. Aslanides, F. Jundt, and E. Jacobs. 175, 1426 (1968)

Study of Levels in $^{22}$Ne, $^{26}$Mg, and $^{34}$S by Proton Pickup—B. H. Wildenthal and E. Newman. 175, 1431 (1968)

Lifetime Measurements from the $K^{39}(p,\gamma)Ca^{40}$ Reaction—K. W. Dolan and D. K. McDaniels. 175, 1446 (1968)

Level Scheme and Configuration Mixing in $Sc^{44}$—J. J. Schwartz. 175, 1453 (1968)

Measurements of $L_2$- and $L_3$-Subshell Fluorescence Yields in Heavy Elements—Richard E. Price, Hans Mark, and C. D. Swift. 176, 3 (1968)

Hindrance Factors for Beta Decays of Heavy Nuclei—Hiroyasu Ejiri, Kiyomi Ikeda, and Jun-Ichi Fujita. 176, 1277 (1968)

$2^-$ Isobaric Analog Resonance in the $^{89}Y(p,n_2)^{89}$Zr Reaction and the Excited States of $^{89}$Zr—G. C. Dutt, F. Gabbard, J. J. Egan, and J. E. Wiest. 176, 1289 (1968)

$Ne^{22}(t,p\gamma)Ne^{24}$ Angular Correlation Study—J. A. Becker, L. F. Chase, Jr., R. E. McDonald, and E. K. Warburton. 176, 1310 (1968)

Gamma Rays from the Decay of $^{75}$Ge and $^{77}$Ge—Anne Ng, R. E. Wood, J. M. Palms, P. Venugopala Rao, and R. W. Fink. 176, 1329 (1968)

Level Spectra of Odd Isotopes of Ga, As, Br, and Rb in the Coriolis Coupling Model with a Residual Interaction of the Pairing Type—W. Scholz and F. B. Malik. 176, 1355 (1968)

## 54.3 Nuclear Reactions and Scattering — of Photons

Nuclear Resonance Fluorescence in $Cu^{65}$—F. R. Metzger. 171, 1257 (1968)

Second Born Corrections to Wide-Angle High-Energy Electron Pair Production and Bremsstrahlung—Stanley J. Brodsky and John R. Gillespie. 173, 1011 (1968)

Gamma-Ray Widths of the 3.00-MeV Level of $Al^{27}$ and the 3.13-MeV Level of $P^{31}$—S. W. Robinson, C. P. Swann, and V. K. Rasmussen. 174, 1320 (1968)

Fast-Photoneutron Spectra due to 55–85-MeV Photons—N. N. Kaushal, E. J. Winhold, P. F. Yergin, H. A. Medicus, and R. H. Augustson. 175, 1330 (1968)

Dipole States in $Sr^{88}$—B. Goulard, T. A. Hughes, and S. Fallieros. 176, 1345 (1968)

Measurements of the $^{63}$Cu$(\gamma,n)$ and $(\gamma,2n)$ Cross Sections—R. E. Sund, M. P. Baker, L. A. Kull, and R. B. Walton. 176, 1366 (1968)

## 54.4 —— of Leptons, Mesons, and Hyperons

Inelastic Electron Scattering from $^{24}$Mg at 180°—L. W. Fagg, W. L. Bendel, R. A. Tobin, and H. F. Kaiser. 171, 1250 (1968)

Inelastic Electron Scattering from $^{26}$Mg at 180°—W. L. Bendel, L. W. Fagg, R. A. Tobin, and H. F. Kaiser. 173, 1103 (1968)

Double Charge Exchange of Positive $\pi$ Mesons on Complex Nuclei—P. E. Boynton, Thomas J. Devlin, J. Solomon, and V. Perez-Mendez. 174, 1083 (1968)

Pion Double-Charge-Exchange Cross-Section Measurements—C. J. Cook, M. E. Nordberg, Jr., and R. L. Burman. 174, 1374 (1968)

Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)

## 54.5 —— of Protons

Energy Levels of $^{46}$Sc—W. J. McDonald, J. T. Sample, D. M. Sheppard, G. M. Stinson, and K. W. Jones. 171, 1254 (1968)

Comparison of Calculated Radiochemical Cross Sections with Experimental Results for Incident Protons and $\pi^-$ Mesons in the 50- to 400-MeV Region: Effect of Varying a Few Nuclear Parameters in the Calculations—Hugo W. Bertini. 171, 1261 (1968)

Production of Neon-24 and Sodium-24 in the 1–3-GeV Proton Bombardment of Copper, Silver, Gold, and Uranium Targets—J. Hudis. 171, 1301 (1968)

$(p,d)$ Reaction on $N = Z$ Nuclei in the $2s$-$1d$ Shell—R. L. Kozub. 172, 1078 (1968)

Excitation Functions for Radioactive Isotopes Produced by Proton-Induced Reactions in Silicon—D. W. Sheffey, L. R. Williams, and C. B. Fulmer. 172, 1094 (1968)

Analysis of Two-Neutron ($L = 0$) Transfer Cross Sections for Calcium and Nickel—B. F. Bayman and Norton M. Hintz. 172, 1113 (1968)

Energy Levels in $^{89}$Y—P. F. Hinrichsen, S. M. Shafroth, and D. M. Van Patter. 172, 1134 (1968)

Proton-Induced Reactions on $^{40}$Ar and Analogs of $^{41}$Ar Levels—H. L. Scott, W. Galati, J. L. Weil, and M. T. McEllistrem. 172, 1139 (1968)

$^{40}Ar(p,n)^{40}K$ Reaction from Threshold to 5.0 MeV—T. M. Young, J. D. Brandenberger, and F. Gabbard. 172, 1148 (1968)

Gamma Rays from the $Sc^{45}(p,p'\gamma)$ Reaction—C. Chasman, K. W. Jones, and R. A. Ristinen. 173, 1072 (1968)

Angular Distributions of the Recoil Nuclei from the $Cu^{65}(p,pn)Cu^{64}$ Reactions at 0.37, 1.0, and 2.8 GeV—L. P. Remsberg. 174, 1338 (1968)

Influence of Angular Momentum on the Decay of the $Ni^{60}$ Compound Nucleus—J. Benveniste, G. Merkel, and A. Mitchell. 174, 1357 (1968)

Measurements and Analyses of the $d_{5/2}$ Analog Resonance in the $^{88}Sr(p,n)^{88}Y$ Reaction—G. C. Dutt and R. Schrils. 175, 1413 (1968)

Lifetime Measurements from the $K^{39}(p,\gamma)Ca^{40}$ Reaction—K. W. Dolan and D. K. McDaniels. 175, 1446 (1968)

11-MeV Proton Optical-Model Analysis—C. M. Perey, F. G. Perey, J. K. Dickens, and R. J. Silva. 175, 1460 (1968)

Scattering of 24.5-MeV Protons from $^{89}$Y—W. Benenson, S. M. Austin, R. A. Paddock, and W. G. Love. 176, 1268 (1968)

$2^-$ Isobaric Analog Resonance in the $^{89}Y(p,n_2)^{89}$Zr Reaction and the Excited States of $^{89}$Zr—G. C. Dutt, F. Gabbard, J. J. Egan, and J. E. Wiest. 176, 1289 (1968)

High-Resolution Study of Isobaric Analog Resonances in $^{23}$Na—G. A. Keyworth, P. Wilhjelm, G. C. Kyker, Jr., H. W. Newson, and E. G. Bilpuch. 176, 1302 (1968)

### 54.6 —— of Neutrons

Direct Neutron Capture in $Co^{59}(n,\gamma)Co^{60}$—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 176, 1314 (1968)

Small-Angle Scattering of Neutrons by Heavy Nuclei—F. T. Kuchnir, A. J. Elwyn, J. E. Monahan, A. Langsdorf, Jr., and F. P. Mooring. 176, 1405 (1968)

### 54.7 —— of Deuterons and Tritons

Analysis of Two-Neutron ($L = 0$) Transfer Cross Sections for Calcium and Nickel—B. F. Bayman and Norton M. Hintz. 172, 1113 (1968)

Nuclear-Reaction Studies in the Strontium Isotopes: Neutron Particle-Hole States in $Sr^{88}$ and the $Sr^{87}(d,p)Sr^{88}$ Reaction—E. R. Cosman and D. C. Slater. 172, 1126 (1968)

Study of Levels in $^{22}Ne$, $^{26}Mg$, and $^{34}S$ by Proton Pickup—B. H. Wildenthal and E. Newman. 175, 1431 (1968)

$^{31}P(d,\alpha)^{29}Si$ Reaction from 7.3 to 12.0 MeV—G. A. Lock, J. R. Curry, P. J. Riley, and C. G. Shugart. 176, 1293 (1968)

### 54.8 —— of $He^3$ and $He^4(\alpha)$

Optical-Model Analysis of Alpha-Particle Scattering by $^{40}Ca$ from 12 to 18 MeV—C. P. Robinson, J. P. Aldridge, Joseph John, and R. H. Davis. 171, 1241 (1968)

Two-Particle, Two-Hole States in $^{40}K$ from the Study of the $^{40}Ar(^3He,^3H)^{40}K$ Reaction—J. J. Wesolowski, Luisa F. Hansen, and M. L. Stelts. 172, 1072 (1968)

Inelastic Scattering of 42-MeV Alpha Particles from $K^{39}$ and $V^{51}$—R. J. Peterson. 172, 1098 (1968)

Angular-Distribution Study of the $Cu^{65}(He^3,x\alpha)$ Reaction Products—I. Fujiwara and N. T. Porile. 173, 1055 (1968)

Influence of Angular Momentum on the Decay of the $Ni^{60}$ Compound Nucleus—J. Benveniste, G. Merkel, and A. Mitchell. 174, 1357 (1968)

Scattering of Medium-Energy Alpha Particles. I. Phenomenological Analysis of Elastic Scattering—Daphne F. Jackson and C. G. Morgan. 175, 1402 (1968)

Collective Effects in the $P^{31}(He^3,p)S^{33}$ Reaction—R. S. Cox, R. W. West, and R. J. Ascuitto. 175, 1419 (1968)

Study of the $Na^{23}(He^3,d)Mg^{24}$ Reaction—R. C. Bearse and J. L. Ystema. 175, 1442 (1968)

Level Scheme and Configuration Mixing in $Sc^{44}$—J. J. Schwartz. 175, 1453 (1968)

Differential Range Study of $(\alpha,x\alpha)$ Reactions of Copper—N. T Porile and I. Fujiwara. 176, 1166 (1968)

($^3He,\alpha$) Reaction on $^{89}Y$ and $^{86}Kr$ at 18 MeV—C. M. Fou and R. W. Zurmühle. 176, 1339 (1968)

### 54.9 —— of Heavy Nuclei

Study of the Particles Emitted from $Br^{75}$ Compound Nuclei Formed in Two Ways: $C^{12} + Cu^{63}$ and $O^{16} + Co^{59}$—J. M. D'Auria, M. J. Fluss, G. Herzog, L. Kowalski, J. M. Miller, and R. C. Reedy. 174, 1409 (1968)

## 55 NUCLEI WITH $90 \leq A$

### 55.1 Properties; Mass, Abundance, Moments, and Spin (see also 11.4 and 21.4)

Isomer Shift and Hyperfine Splittings of the 59.6-keV Mössbauer Resonance in $^{237}Np$—B. D. Dunlap, G. M. Kalvius, S. L. Ruby, M. B. Brodsky, and D. Cohen. 171, 316 (1968)

Hyperfine Structure of $Au^{197}$ in Fe Measured with the Mössbauer Effect—R. L. Cohen. 171, 343 (1968)

Three-Quasiparticle Intruder State in $Te^{125}$ and the Magnetic Moment of $Sb^{125}$—N. J. Stone, R. B. Frankel, and D. A. Shirley. 172, 1243 (1968)

Precise Muonic K$\alpha$ Isotope Shifts for Nuclides from Si to Sn—R. D. Ehrlich. 173, 1088 (1968)

Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions—Thomas C. Tucker, Louis D. Roberts, C. W. Nestor, Jr., Thomas A. Carlson, and F. B. Malik. 174, 118 (1968)

Nuclear Properties and Magnetic Hyperfine Interaction of $Os^{189}$—B. Persson, H. Blumberg, and M. Bent. 174, 1509 (1968)

Erratum: Nuclear Magnetic Resonance and Relaxation in Iridium Metal: The Nuclear Magnetic Dipole Moments of $^{191}Ir$ and $^{193}Ir$—Albert Narath. [165, 506 (1968)] 175, 696 (1968)

$g$-Factor Measurement of a Three-Particle Isomeric State of $^{209}Po$ Following Pulsed Generation in $(\alpha,x\pi)$ Reactions—T. Yamazaki and E. Matthias. 175, 1476 (1968)

Nuclear-Matter Sizes in the Tin Isotopic Sequence—Richard N. Boyd and G. W. Greenlees. 176, 1394 (1968)

### 55.2 Spectroscopy; Decay, Energy Levels, and Transitions

K-x-Ray-$\gamma$-Ray Directional Correlation in the Decay of $Ba^{133}$—Michael McDonnell and M. K. Ramaswamy. 171, 1278 (1968)

Lifetime of the 603-keV Level of $Te^{124}$—M. Schumacher. 171, 1279 (1968)

High-Resolution Gamma-Ray Spectroscopic Studies of the Decays of 2.6-h $Nd^{141g}$ and 60-sec $Nd^{141m}$—D. B. Beery, W. H. Kelly, and Wm. C. McHarris. 171, 1283 (1968)

Decay of $Ho^{163}$—P. K. Hopke, J. S. Evans, and R. A. Naumann. 171, 1290 (1968)

Neutron Groups in the Spectrum of a $PuF_4$ Source—Richard L. Lehman. 171, 1311 (1968)

Alpha Decay of $^{243}Am$—J. R. Van Hise and D. Engelkemeir. 171, 1325 (1968)

Directional Correlations in the Decay of $^{148}Pm$—L. D. Wyly, E. T. Patronis, Jr., and C. H. Braden. 172, 1153 (1968)

Deformation in the Light Ba Isotopes: Isomeric States of $Ba^{125}$ and $Ba^{127}$—J. M. D'Auria, H. Bakhru, and I. L. Preiss. 172, 1176 (1968)

Neutron Hole States in $Z = 40$ Nuclei Studied with the $(p,d)$ Reaction on $^{90}Zr$, $^{91}Zr$, and $^{92}Zr$—J. B. Ball and C. B. Fulmer. 172, 1199 (1968)

Decay of $^{136}La$ and $^{134}La$—Glenn M. Julian and Theodore E. Fessler. 172, 1208 (1968)

Beta Decay of $^{146}Ce$—D. C. Hoffman, F. O. Lawrence, and W. R. Daniels. 172, 1239 (1968)

Three-Quasiparticle Intruder State in $Te^{125}$ and the Magnetic Moment of $Sb^{125}$—N. J. Stone, R. B. Frankel, and D. A. Shirley. 172, 1243 (1968)

Levels in $^{133}I$ from the Decay of $^{133m}Te$ and $^{133g}Te$—L. D. McIsaac. 172, 1253 (1968)

Success and Limitations of Two- and Four-Quasiparticle Tamm-Dancoff Theories of Vibrational States: Applications to Even Tin Isotopes with a Realistic Nucleon-Nucleon Potential—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 173, 964 (1968)

Proton Decay of Analog States Formed in the $(d,n)$ Reaction—N. Cue and Patrick Richard. 173, 1108 (1968)

Total Internal-Conversion Coefficients for Low-Energy $E2$ Transitions in $Ra^{224}$, $Th^{228}$, $U^{234}$, $U^{236}$, and $Pu^{240}$—C. L. Duke and W. L. Talbert, Jr. 173, 1125 (1968)

Static Nuclear Deformation Effects in Internal Conversion—J. J. Matese. 173, 1165 (1968)

High-Resolution Gamma-Ray Spectroscopic Study of the Decay $^{133}Ba \rightarrow {}^{133}Cs$—D. P. Donnelly, J. J. Reidy, and M. L. Wiedenbeck. 173, 1192 (1968)

Isomer Ratio of $Ce^{137m}$ to $Ce^{137g}$ Produced in Several Charged-Particle Reactions—R. L. Kiefer and K. Street, Jr. 173, 1202 (1968)

Study of the $Nb^{93}(n_{res},\gamma)Nb^{94}$ Reaction—W. V. Prestwich, R. E. Coté, and Hla Shwe. 174, 1421 (1968)

Test of Time-Reversal Invariance via a $\beta$-$\gamma$-$\gamma$ Angular Correlation in $^{106}Rh$-$^{106}Pd$—R. B. Perkins and E. T. Ritter. 174, 1426 (1968)

Levels in Even-Even $Hg^{192}$, $Hg^{194}$, $Hg^{196}$, and $Hg^{198}$—R. F. Petry, R. A. Naumann, and J. S. Evans. 174, 1441 (1968)

Levels of $^{130}Xe$ Populated in $\beta$ Decay of $^{130}I$ and $^{130}Cs$—Theodore E. Fessler, Glenn M. Julian, and S. Jha. 174, 1472 (1968)

Transitional Nuclei. II. Higher Vibrational States in Nucleus $^{154}Gd$—R. A. Meyer. 174, 1478 (1968)

Alpha Decay of the Isomers of $^{214}Fr$—David F. Torgerson, Richard A. Gough, and Ronald D. Macfarlane. 174, 1494 (1968)

Total Internal Conversion Coefficient of the 23.9-keV Ground-State Transition in $^{119m}Sn$—Vaclav O. Koustroun and Bernd Crasemann. 174, 1535 (1968)

Green's Velocity-Dependent Potential in the Shell Model of $Po^{210}$, $Pb^{210}$, and $Bi^{210}$—P. S. Ganas and Bruce H. J. McKellar. 175, 1409 (1968)

$g$-Factor Measurement of a Three-Particle Isomeric State of $^{209}Po$ Following Pulsed Generation in $(\alpha, x\pi)$ Reactions—T. Yamazaki and E. Matthias. 175, 1476 (1968)

Xenon-134 from the Decay of Cesium-134—E. C. Alexander, Jr., G. A. Bennett, B. Srinivasan, and O. K. Manuel. 175, 1494 (1968)

A $K^{\pi} = 0^{+}$ Band in $^{184}W$—K. T. Faler, R. R. Spencer, and R. A. Harlan. 175, 1495 (1968)

Decay Studies of Iodine-118 and -120—Inge-Maria Ladenbauer-Bellis and H. Bakhru. 175, 1507 (1968)

Alpha Branching Ratio in the Decay of $^{149}Tb$—Y. Y. Chu, E. M. Franz, and G. Friedlander. 175, 1523 (1968)

Characteristics of the Transition-State Spectra for $^{234}U$, $^{236}U$, and $^{240}Pu$ from $(d,pf)$ and $(t,pf)$ Angular-Correlation Experiments—H. C. Britt, F. A. Rickey, Jr., and W. S. Hall. 175, 1525 (1968)

Hindrance Factors for Beta Decays of Heavy Nuclei—Hiroyasu Ejiri, Kiyomi Ikeda, and Jun-Ichi Fujita. 176, 1277 (1968)

New Isotopes of Thorium Studied with an Improved Helium-Jet Recoil Transport Apparatus—Kalevi Valli and Earl K. Hyde. 176, 1377 (1968)

## 55.3 Nuclear Reactions and Scattering — of Photons

Fast-Photoneutron Spectra due to 55–85-MeV Photons—N. N. Kaushal, E. J. Winhold, P. F. Yergin, H. A. Medicus, and R. H. Augustson. 175, 1330 (1968)

## 55.4 —— of Leptons, Mesons, and Hyperons

Scattering of $\beta$ Radiation on a Thick Foil: Production of Transverse Polarization—L. Braicovich, B. De Michelis, and A. Fasana. 174, 460 (1968)

Double Charge Exchange of Positive $\pi$ Mesons on Complex Nuclei—P. E. Boynton, Thomas J. Devlin, J. Solomon, and V. Perez-Mendez. 174, 1083 (1968)

Comparison of Experiment and Theory for Nuclear Excitation in $^{115}In$ by Threshold-Energy Electrons—B. T. Chertok and W. T. K. Johnson. 174, 1525 (1968)

## 55.5 —— of Protons

Production of $^{7}Be$, $^{22}Na$, and $^{24}Na$ Fragments from Heavy Elements at 3, 10, and 30 GeV—J. Hudis and S. Tanaka. 171, 1297 (1968)

Production of Neon-24 and Sodium-24 in the 1–3-GeV Proton Bombardment of Copper, Silver, Gold, and Uranium Targets—J. Hudis. 171, 1301 (1968)

Two-Neutron-Hole Configurations in $Pb^{206}$ from Isobaric Analog Measurements—Patrick Richard, Nelson Stein, C. D. Kavaloski, and J. S. Lilley. 171, 1308 (1968)

Neutron Hole States in $Z = 40$ Nuclei Studied with the $(p,d)$ Reaction on $^{90}Zr$, $^{91}Zr$, and $^{92}Zr$—J. B. Ball and C. B. Fulmer. 172, 1199 (1968)

Fission Energetics and Neutron Emission in 13-MeV Proton-Induced Fission of $^{226}Ra$—E. Konecny and H. W. Schmitt. 172, 1213 (1968)

Asymmetry, Anisotropy, and Excitation Function for the Proton-Induced Fission of $^{226}Ra$—E. Konecny and H. W. Schmitt. 172, 1226 (1968)

Neutron Spectroscopic Factors from Isobaric Analog States—W. J. Thompson, J. L. Adams, and D. Robson. 173, 975 (1968)

One-Neutron Transfer Reactions in Even and Odd Tin Isotopes and a Realistic Nucleon-Nucleon Potential—R. Alzetta and J. Sawicki. 173, 1185 (1968)

Elastic and Inelastic Proton Scattering from Even Isotopes of Cd, Sn, and Te—W. Makofske, W. Savin, H. Ogata, and T. H. Kruse. 174, 1429 (1968)

Fission of $U^{238}$ by 2.2-GeV Protons—V. P. Crespo, J. B. Cumming, and A. M. Poskanzer. 174, 1455 (1968)

Isobaric-Analog Study of $^{90}Zr$—K. P. Lieb, James J. Kent, and C. Fred Moore. 175, 1482 (1968)

Isobaric Analog Resonances in Proton Scattering from $^{124}Te$, $^{126}Te$, $^{128}Te$, and $^{130}Te$—J. L. Foster, Jr., P. J. Riley, and C. Fred Moore. 175, 1498 (1968)

Nuclear-Matter Sizes in the Tin Isotopic Sequence—Richard N. Boyd and G. W. Greenlees. 176, 1394 (1968)

Determination of Total Widths and Resonance Energies of the Single-Particle Analog Resonances in $^{209}Bi$—W. R. Wharton, P. von Brentano, W. K. Dawson, and Patrick Richard. 176, 1424 (1968)

## 55.6 —— of Neutrons

$p$-Wave Resonances of $U^{238}$—L. M. Bollinger and G. E. Thomas. 171, 1293 (1968)

Nuclear Levels in $^{142}Pr$—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)

$Au^{197}(n,\gamma)Au^{198}$ Reaction Mechanism—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 173, 1170 (1968)

Neutron Cross Sections and Resonance Parameters of Yb Isotopes—S. F. Mughabghab and R. E. Chrien. 174, 1400 (1968)

Neutron Scattering Cross Sections of $U^{233}$, $U^{235}$, and $Pu^{241}$ from 1 to 30 eV—G. D. Sauter and C. D. Bowman. 174, 1413 (1968)

Study of the $Nb^{93}(n_{res},\gamma)Nb^{94}$ Reaction—W. V. Prestwich, R. E. Coté, and Hla Shwe. 174, 1421 (1968)

$Ba^{137}(n,\gamma)$ Reaction and Level Structure of $Ba^{138}$—M. A. J. Mariscotti, W. Gelletly, J. A. Moragues, and W. R. Kane. 174, 1485 (1968)

Resonant and Nonresonant Capture of Slow Neutrons in $Tm^{169}(n,\gamma)Tm^{170}$—M. A. Lone, R. E. Chrien, O. A. Wasson, M. Beer, M. R. Bhat, and H. R. Muether. 174, 1512 (1968)

Note on the Scattering Cross Sections of the Isotopes of Dysprosium—H. R. Child, L. J. Raubenheimer, W. C. Koehler, and R. M. Moon. 174, 1553 (1968)

Neutron Resonances of $Th^{230}$—R. E. Cotté, H. Diamond, J. E. Gindler, and Hla Shwe. 176, 1421 (1968)

55.7 —— of Deuterons and Tritons

Proton Decay of Analog States Formed in the $(d,n)$ Reaction—N. Cue and Patrick Richard. 173, 1108 (1968)

Nuclear Levels in $^{143}Pr$—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)

One-Neutron Transfer Reactions in Even and Odd Tin Isotopes and a Realistic Nucleon-Nucleon Potential—R. Alzetta and J. Sawicki. 173, 1185 (1968)

$^{136}Xe(d,p)$ and $^{136}Xe(d,t)$ Reactions—P. A. Moore, P. J. Riley, C. M. Jones, M. D. Mancusi, and J. L. Foster, Jr. 175, 1516 (1968)

Characteristics of the Transition-State Spectra for $^{234}U$, $^{236}U$, and $^{240}Pu$ from $(d,pf)$ and $(t,pf)$ Angular-Correlation Experiments—H. C. Britt, F. A. Rickey, Jr., and W. S. Hall. 175, 1525 (1968)

$g_{7/2}$-$h_{11/2}$ Anomaly in Stripping Studies near $A=110$—B. L. Cohen, R. A. Moyer, J. B. Moorhead, L. H. Goldman, and R. C. Diehl. 176, 1401 (1968)

Experimental Study of the $(d,He^3)$ Reaction on Even-$A$ Isotopes of Mo—H. Ohnuma and J. L. Yntema. 176, 1416 (1968)

55.8 —— Of $He^3$ and $He^4(\alpha)$

Levels of $Bi^{209}$ Observed in the $Pb^{208}(He^3,d)$ Reaction—John Bardwick and Robert Tickle. 171, 1305 (1968)

Core Excitations in $^{107}Ag$, $^{109}Ag$, $^{113}In$, $^{115}In$, $^{121}Sb$, and $^{123}Sb$ Resulting from Inelastic Scattering of 42-MeV Alpha Particles—W. M. Stewart, N. Baron, and R. F. Leonard. 171, 1316 (1968)

Isomer Ratio of $Ce^{137m}$ to $Ce^{137g}$ Produced in Several Charged-Particle Reactions—R. L. Kiefer and K. Street, Jr. 173, 1202 (1968)

Intensities and Angular Distributions of Ground-State Rotational Transitions Excited in $(\alpha,3n)$ and $(\alpha,4n)$ Reactions—C. F. Williamson, S. M. Ferguson, B. J. Shepherd, and I. Halpern. 174, 1544 (1968)

55.9 —— of Heavy Nuclei

Analysis of Excitation Functions in Cm(C,$xn$)No Reactions—Torbjorn Sikkeland, Albert Ghiorso, and Matti J. Nurmia. 172, 1232 (1968)

Isomer Ratio of $Ce^{137m}$ to $Ce^{137g}$ Produced in Several Charged-Particle Reactions—R. L. Kiefer and K. Street, Jr. 173, 1202 (1968)

New Isotopes of Thorium Studied with an Improved Helium-Jet Recoil Transport Apparatus—Kalevi Valli and Earl K. Hyde. 176, 1377 (1968)

56 NUCLEAR FISSION

Structure of the Fission Transition Nucleus $U^{235}$—A. N. Behkami, J. H. Roberts, W. Loveland, and J. R. Huizenga. 171, 1267 (1968)

Fission-Fragment Mass and Charge Distribution for the Moderately Excited $U^{236}$ Compound Nucleus—J. A. McHugh and M. C. Michel. 172, 1160 (1968)

Ternary Fission of $U^{238}$ Induced by Intermediate-Energy Helium Ions—R. H. Iyer and J. W. Cobble. 173, 1186 (1968)

Fission of Iridium at Intermediate Excitation Energies—R. L. Brodzinski and J. W. Cobble. 172, 1194 (1968)

Fission Energetics and Neutron Emission in 13-MeV Proton-Induced Fission of $^{226}Ra$—E. Konecny and H. W. Schmitt. 172, 1213 (1968)

Asymmetry, Anisotropy, and Excitation Function for the Proton-Induced Fission of $^{226}Ra$—E. Konecny and H. W. Schmitt. 172, 1226 (1968)

Analysis of Excitation Functions in Cm(C,$xn$)No Reactions—Torbjorn Sikkeland, Albert Ghiorso, and Matti J. Nurmia. 172, 1232 (1968)

Thermal-Neutron Fission of $^{235}U$: Identification and Fractional Chain Yield of 17-sec $^{77}Ga$—L. Wish. 172, 1262 (1968)

Identification of 5.3-sec $^{118}Ag$ as a Product of $^{235}U$ Fission—H. V. Weiss, J. M. Fresco, and W. L. Reichert. 172, 1266 (1968)

Identification and Yield of 5.0-sec $^{117}Pd$ in the Thermal-Neutron Fission of $^{235}U$—H. V. Weiss, J. L. Elzie, and J. M. Fresco. 172, 1269 (1968)

Light Nuclei Emitted in the Fission of $^{252}Cf$—G. M. Raisbeck and T. D. Thomas. 172, 1272 (1968)

Cumulative Fission Yield and Half-Life of $^{134}Sb$—A. A. Delucchi, A. E. Greendale, and P. O. Strom. 173, 1159 (1968)

Neutron Scattering Cross Sections of $U^{233}$, $U^{235}$, and $Pu^{241}$ from 1 to 30 eV—G. D. Sauter and C. D. Bowman. 174, 1413 (1968)

Fission of $U^{238}$ by 2.2-GeV Protons—V. P. Crespo, J. B. Cumming, and A. M. Poskanzer. 174, 1455 (1968)

Spontaneous-Fission Decay Constant of $^{238}U$—J. H. Roberts, Raymond Gold, and Roland J. Armani. 174, 1482 (1968)

Fission-Fragment Energy-Correlation Measurements for the Thermal-Neutron Fission of $^{233}U$—Frances Pleasonton. 174, 1500 (1968)

Nuclear Pairing Energy of Transition Nucleus $Pu^{240}$—J. R. Huizenga, A. N. Behkami, J. W. Meadows, Jr., and E. D. Klema. 174, 1539 (1968)

Characteristics of the Transition-State Spectra for $^{234}U$, $^{236}U$, and $^{240}Pu$ from $(d,pf)$ and $(t,pf)$ Angular-Correlation Experiments—H. C. Britt, F. A. Rickey, Jr., and W. S. Hall. 175, 1525 (1968)

60 ELEMENTARY PARTICLES AND FIELDS

61 EXTRATERRESTRIAL PHYSICS; GRAVITATION

61.2 Cosmic Rays (see also 61.4)

Antiprotons and Positrons in Cosmic Rays—C. S. Shen and G. B. Berkey. 171, 1344 (1968)

Origin of Primary Cosmic Radiation and Its Antiproton Component—J. R. Wayland and Theodore Bowen. 171, 1376 (1968)

Search for Heavy Triplets in Cosmic Rays—H. Kasha and R. J. Stefanski. 172, 1297 (1968)

Diffraction-Disassociation Model of Very-High-Energy Nucleon-Nucleon Interactions and the Diffusion of Cosmic Rays through the Atmosphere—Robert K. Adair. 172, 1370 (1968)

Cosmic-Ray Propagation—C. E. Fichtel and D. V. Reames. 175, 1564 (1968)
Very Heavy Nuclei in the Primary Cosmic Radiation. I. Observations on the Energy Spectrum—P. S. Freier and C. J. Waddington. 175, 1641 (1968)
Very Heavy Nuclei in the Primary Cosmic Radiation. II. Interpretation of the Energy Spectra—C. J. Waddington and P. S. Freier. 175, 1649 (1968)
Two-Temperature Statistical Model of Particle Spectra—J. R. Wayland. 175, 2106 (1968)
Inverse Compton Effect and Universal 3°K Radiation—Ludwig Oster. 176, 1501 (1968)
Search for Cosmic Gamma Radiation in the Southern Sky—J. G. Duthie and R. W. Osborn. 176, 1505 (1968)
Experimental Tests of Cascade Theory at High Energies—R. Holynski, W. V. Jones, and K. Pinkau. 176, 1661 (1968)

## 61.4 Astrophysics (see also 61.2 and 61.6)

Quasars and Quarks—J. C. Huang and T. W. Edwards. 171, 1331 (1968)
Exact Internal Solutions for Dense Massive Stars—M. C. Durgapal and G. L. Gehlot. 172, 1308 (1968)
Equation of State at Supranuclear Densities and the Existence of a Third Family of Superdense Stars—Ulrich H. Gerlach. 172, 1325 (1968)
$N^{14}(\alpha,\gamma)F^{18}$ Reaction—P. D. Parker. 173, 1021 (1968)
Quantum Theory of an Electron Gas in Intense Magnetic Fields—Vittorio Canuto and Hong-Yee Chiu. 173, 1210 (1968)
Thermodynamic Properties of a Magnetized Fermi Gas—Vittorio Canuto and Hong-Yee Chiu. 173, 1220 (1968)
Magnetic Moment of a Magnetized Fermi Gas—Vittorio Canuto and Hong-Yee Chiu. 173, 1229 (1968)
Self-Consistent Homogeneous Isotropic Cosmological Models I. Generalities—Rémi Hakim. 173, 1235 (1968)
Gravitational Collapse of Rotating Bodies—Jeffrey M. Cohen. 173, 1258 (1968)
Possible Weak Interaction of Photons and Emission of Neutrinos from Stars—Pratul Bandyopadhyay. 173, 1481 (1968)
Transport Theory of a Partially Degenerate Plasma—Martin Lampe. 174, 276 (1968)
Axially Symmetric Zero-Mass Meson Solutions of Einstein Equations—R. Penney. 174, 1578 (1968)
Theory for the Measurement of the Earth's Velocity through the 3°K Cosmic Radiation—C. V. Heer and R. H. Kohl. 174, 1611 (1968)
Nonstatic Analogs of Schwarzschild's Interior Solution in General Relativity—P. C. Vaidya. 174, 1615 (1968)
Effect of a Degenerate Neutrino Sea on Electromagnetism—J. Royer. 174, 1719 (1968)
Comment on the Anisotropy of the Primeval Fireball—P. J. E. Peebles and David T. Wilkinson. 174, 2168 (1968)
Erratum: Finite Electronic Partition Function from Screene Coulomb Interactions—Carl A. Rouse. [163, 62 (1967)] 176, 423 (1968)
Quantum Theory of an Electron Gas with Anomalous Magnetic Moments in Intense Magnetic Fields—Hong-Yee Chiu, Vittorio Canuto, and Laura Fassio-Canuto. 176, 1438 (1968)
Distribution of Blackbody Cavity Radiation in a Moving Frame of Reference—G. R. Henry, R. B. Feduniak, J. E. Silver, and M. A. Peterson. 176, 1451 (1968)
Relative Proton Number in Neutron Star Matter—J. Nemeth and Donald W. L. Sprung. 176, 1496 (1968)
Inverse Compton Effect and Universal 3°K Radiation—Ludwig Oster. 176, 1501 (1968)
Search for Cosmic Gamma Radiation in the Southern Sky—J. G. Duthie and R. W. Osborn. 176, 1505 (1968)

## 61.6 Gravitation and General Relativity

Canonical Quantization of Gravitational Field—Asher Peres. 171, 1335 (1968)
Gravitationally Induced Electric Field near a Conductor, and Its Relation to the Surface-Stress Concept—Conyers Herring. 171, 1361 (1968)
Erratum: Quantum Theory of Gravity. I. The Canonical Theory—Bryce S. DeWitt. [160, 1113 (1967)] 171, 1834 (1968)
Erratum: Quantum Theory of Gravity. II. The Manifestly Covariant Theory—Bryce S. DeWitt. [162, 1195 (1967)] 171, 1834 (1968)
Erratum: Quantum Theory of Gravity. III. Applications of the Covariant Theory—Bryce S. DeWitt. [162, 1239 (1967)] 171, 1834 (1968)
Interior Solution for a Finite Rotating Body of Perfect Fluid—Hugo D. Wahlquist. 172, 1291 (1968)
Supplementary Conditions in the Quantized Gravitational Theory—Suraj N. Gupta. 172, 1303 (1968)
Exact Internal Solutions for Dense Massive Stars—M. C. Durgapal and G. L. Gehlot. 172, 1308 (1968)
Klein-Gordon Geon—David J. Kaup. 172, 1331 (1968)
Erratum: New Formulation of the Axially Symmetric Gravitational Field Problem. II—Frederick J. Ernst. [168, 1415 (1968)] 172, 1850 (1968)
Self-Consistent Homogeneous Isotropic Cosmological Models. I. Generalities—Rémi Hakim. 173, 1235 (1968)
Gravitational Collapse of Rotating Bodies—Jeffrey M. Cohen. 173, 1258 (1968)
Sources and Gravitons—Julian Schwinger. 173, 1264 (1968)
Low-Energy-Theorem Approach to Single-Particle Singularities in the Presence of Massless Bosons—R. Jackiw and L. Soloviev. 173, 1485 (1968)
Global Structure of the Kerr Family of Gravitational Fields—Brandon Carter. 174, 1559 (1968)
Axially Symmetric Zero-Mass Meson Solutions of Einstein Equations—R. Penney. 174, 1578 (1968)
Nonstatic Analogs of Schwarzschild's Interior Solution in General Relativity—P. C. Vaidya. 174, 1615 (1968)
Lunar Laser Ranging and the Brans-Dicke Theory—Christine Krogh and Ralph Baierlein. 175, 1576 (1968)
Feynman Rules for the Gravitational Field from the Coordinate-Independent Field-Theoretic Formalism—Stanley Mandelstam. 175, 1604 (1968)
Equivalence Principle and Motion of a Gyroscope—L. Parker. 175, 1658 (1968)
Multipole Particles in Equilibrium in General Relativity—P. Szekeres. 176, 1446 (1968)
Static, Axially Symmetric Point Horizons—Jeffrey Winicour, Allen I. Janis, and Ezra T. Newman. 176, 1507 (1968)
Changes of the Petrov Type of a Space-Time—Lloyd A. Case. 176, 1554 (1968)

# 62 CLASSICAL PHYSICS AND QUANTUM THEORY

## 62.2 Mechanics and Acoustics; Special Relativity (see also 45.1)

Quest for Faster-Than-Light Particles—Torsten Alväger and Michael N. Kreisler. 171, 1357 (1968)
Origin of "Hidden Momentum Forces" on Magnets—Sidney Coleman and J. H. Van Vleck. 171, 1370 (1968)
Causes of Sound Faster than Light in Classical Models of Ultradense Matter—M. Ruderman. 172, 1286 (1968)
Lorentz Invariance, Local Field Theory, and Faster-than-Light Particles—M. E. Arons and E. C. G. Sudarshan. 173, 1622 (1968)

Interaction Angular Momentum—James H. Cooke. 174, 1602 (1968)
Does Lorentz-Invariance Imply Causality?—Michael M. Broido and John G. Taylor. 174, 1606 (1968)
Theory for the Measurement of the Earth's Velocity through the 3°K Cosmic Radiation—C. V. Heer and R. H. Kohl. 174, 1611 (1968)
Comment on the Anisotropy of the Primeval Fireball—P. J. E. Peebles and David T. Wilkinson. 174, 2168 (1968)
Distribution of Blackbody Cavity Radiation in a Moving Frame of Reference—G. R. Henry, R. B. Feduniak, J. E. Silver, and M. A. Peterson. 176, 1451 (1968)
Relativistic Center-of-Mass Variables for Two-Particle Systems with Spin—Hugh Osborn. 176, 1514 (1968)
Maximum Number of Binary Collisions for Three Relativistic Point Particles—G. Doolen. 176, 1541 (1968)

## 62.4 Electromagnetism and Optics (see also 23, 44.4, and 62.8)

Resonant Absorption in the Presence of Faraday Rotation—M. Blume and O. C. Kistner. 171, 417 (1968)
Origin of "Hidden Momentum Forces" on Magnets—Sidney Coleman and J. H. Van Vleck. 171, 1370 (1968)
Time Delay of Scattering Processes—Jorge L. Agudín. 171 1385 (1968)
Erratum: Effect of Angular Correlation on Nonlinear Refractive Index of Liquids—M. Takatsuji. [165, 171 (1968)] 172, 241 (1968)
Quantum Noise. XI. Multitime Correspondence between Quantum and Classical Stochastic Processes—Melvin Lax. 172, 350 (1968)
Quantum Noise. XIII. Six-Classical-Variable Description of Quantum Laser Fluctuations—Melvin Lax and Horace Yuen. 172, 362 (1968)
Boundary Conditions in Maxwell's Theory—Shuang-Yuan Shieh. 172, 1310 (1968)
Motion of a Time-Dependent Harmonic Oscillator, and of a Charged Particle in a Class of Time-Dependent, Axially Symmetric Electromagnetic Fields—H. R. Lewis, Jr. 172, 1313 (1968)
Properties of the Generalized Coherent State—Z. Bialynicka-Birula. 173, 1207 (1968)
An Exact Solution for the Scattering of Electromagnetic Waves from Conductors of Arbitrary Shape. I. Case of Cylindrical Symmetry—Victorr A. Erma. 173, 1243 (1968)
Experimental Upper Limit on the Magnetic Monopole Moment of Electrons, Protons, and Neutrons, Utilizing a Superconducting Quantum Interferometer—Lorin L. Vant-Hull. 173, 1412 (1968)
Quantum Theory of the Smith-Purcell Experiment—Solomon J. Glass and H. Mendlowitz. 174, 57 (1968)
Quantum Optics. II. Description of a Mode—I. R. Senitzky. 174, 1588 (1968)
Quantum Electromagnetic Zero-Point Energy and Retarded Dispersion Forces—Timothy H. Boyer. 174, 1631 (1968)
Effect of a Degenerate Neutrino Sea on Electromagnetism—J. Royer. 174, 1719 (1968)
Quantum Electromagnetic Zero-Point Energy of a Conducting Spherical Shell and the Casimir Model for a Charged Particle—Timothy H. Boyer. 174, 1764 (1968)
Large-Scale Self-Trapping of Optical Beams in the Paraxial Ray Approximation—W. G. Wagner, H. A. Haus, and J. H. Marburger. 175, 256 (1968)
Two-Photon Absorption and Field Correlation Functions—B. R. Mollow. 175, 1555 (1968)
Measurements of Photon Correlations in Partially Coherent Light—D. B. Scarl. 175, 1661 (1968)
Symmetrical Formulation of the Quantum Theory of Three-Wave Optical Parametric Interactions—C. Y. She. 176, 461 (1968)
Distribution of Blackbody Cavity Radiation in a Moving Frame of Reference—G. R. Henry, R. B. Feduniak, J. E. Silver, and M. A. Peterson. 176, 1451 (1968)
Emission of Radiation from a System of Many Excited Atoms—V. Ernst and P. Stehle. 176, 1456 (1968)
Exact Solution for the Scattering of Electromagnetic Waves from Conductors of Arbitrary Shape. II. General Case—Victorr A. Erma. 176, 1544 (1968)
Trajectory and Mass Shift of a Classical Electron in a Radiation Pulse—Joseph H. Eberly and Arthur Sleeper. 176, 1570 (1968)

## 62.6 General Quantum Mechanics (see also 62.8)

Hamiltonian Operator for Velocity-Dependent Potentials—M. Razavy. 171, 1201 (1968)
Wave Equations on a Hyperplane—C. L. Hammer, S. C. McDonald, and D. L. Pursey. 171, 1349 (1968)
Origin of "Hidden Momentum Forces" on Magnets—Sidney Coleman and J. H. Van Vleck. 171, 1370 (1968)
Erratum: Quantum Theory of Gravity. I. The Canonical Theory—Bryce S. DeWitt. [160, 1113 (1967)] 171, 1834 (1968)
Erratum: Quantum Theory of Gravity. II. The Manifestly Covariant Theory—Bryce S. DeWitt. [162, 1195 (1967)] 171, 1834 (1968)
Erratum: Quantum Theory of Gravity. III. Applications of the Covariant Theory—Bryce S. DeWitt. [162, 1239 (1967)] 171, 1834 (1968)
Adiabatic Approximation and Necessary Conditions for the Existence of Bound States—F. H. Gertler, H. B. Snodgrass, and Larry Spruch. 172, 110 (1968)
Interpretation of a Recent Experiment on Interference of Photon Beams—Louis de Broglie and J. Andrade e Silva. 172, 1284 (1968)
General Perturbation and Variational Methods for Responses to Time-Dependent Interactions in Quantum Mechanics—Jean Heinrichs. 172, 1315 (1968)
Wave Equations for Neutral Particles of Arbitrary Spin—D. D. H. Yee. 172, 1539 (1968)
Generalized Perturbation Theory and its Application to the Problem of the Description of Electron Correlation in Atoms and Molecules—Karl F. Freed. 173, 24 (1968)
Upper and Lower Bounds on $s$-Wave Electron-Hydrogen Scattering. I—Rabinder N. Madan. 173, 214 (1968)
Sources and Magnetic Charge—Julian Schwinger. 173, 1536 (1968)
Generalized Superperturbation Theory for Scattering—Rabinder N. Madan. 173, 1615 (1968)
Pressure Shifts of Hyperfine Splitting of Hydrogen and Tritium in Argon—R. A. Brown and F. M. Pipkin. 174, 48 (1968)
Quantum Theory of the Smith-Purcell Experiment—Solomon J. Glass and H. Mendlowitz. 174, 57 (1968)
Tunneling in Ferroelectrics—J. R. Errey. 174, 568 (1968)
Effects of Finite Boundaries on a One-Dimensional Harmonic Oscillator—Richard Vawter. 174, 749 (1968)
Calculation of the Lifetime of a Metastable System—L. Celenza and W. Tobocman. 174, 1115 (1968)
Quantum Treatment of Multiple Real Transitions—J. C. Ashley and R. H. Ritchie. 174, 1572 (1968)
Quantum Optics. II. Description of a Mode—I. R. Senitzky. 174, 1588 (1968)
Quantum-Mechanical Description of Two Coupled Harmonic Oscillators—Lee E. Estes, Thomas H. Keil, and Lorenzo M. Narducci. 175, 286 (1968)

Two-Photon Absorption and Field Correlation Functions—B. R. Mollow. 175, 1555 (1968)
Intrinsic Invariance Groups, Mass Operators, and Linear Wave Equations—Kenneth Rafanelli. 175, 1761 (1968)
Spherical Kemmer Top—Kenneth Rafanelli. 175, 1947 (1968)
n-Particle Kinematics and a Generalized Partial-Wave Analysis—William H. Klink and Granville J. Smith II. 175, 2010 (1968)
Electrodynamics with a Quantum of Length—Kenneth W. Ford. 175, 2048 (1968)
Transformation Properties and Relativistic Equations for Spin-One Elementary Systems—L. Fonda and G. C. Ghirardi. 175, 2082 (1968)
Currents as Coordinates in Nonrelativistic Quantum Mechanics—W. J. Pardee, L. Schlessinger, and Jon Wright. 175, 2140 (1968)
Separated Two-Component Equations for Spin-½ Particles Using Foldy-Wouthuysen-Type Transformations with an Application to the k·p Method in Solids—S. Teitler. 176, 1443 (1968)
Relativistic Center-of-Mass Variables for Two-Particle Systems with Spin—Hugh Osborn. 176, 1514 (1968)
Density Matrices in the Many-Body Problem—P. Gluck. 176, 1534 (1968)
A Path Integral for Spin—Lawrence Schulman. 176, 1558 (1968)
Theories at Infinite Momentum—K. Bardakci and M. B. Halpern. 176, 1686 (1968)
Erratum: General Perturbation and Variational Methods for Responses to Time-Dependent Interactions in Quantum Mechanics—Jean Heinrichs. [172, 1315 (1968)] 176, 2167 (1968)

## 62.8 Quantum Electrodynamics and Other Field Theories (see also 62.4, 62.6, and 64.4)

Canonical Quantization of Gravitational Field—Asher Peres. 171, 1335 (1968)
Formal Breakdown of Lorentz Invariance in Two-Dimensional Field Theories—G. S. Guralnik and C. R. Hagen. 171, 1431 (1968)
Construction of Local Quantum Fields Describing Many Masses and Spins—Henry D. I. Abarbanel and Y. Frishman. 171, 1442 (1968)
Daughter Regge Trajectory in a Field-Theory Model. II—Arthur R. Swift. 171, 1466 (1968)
Singularities of a Bethe-Salpeter Amplitude—H. S. Green and S. N. Biswas. 171, 1511 (1968)
Coupling of the Spacelike and Timelike Wave Functions at Infinite Momentum—Shau-Jin Chang and L. O'Raifeartaigh. 171, 1587 (1968)
Field-Theoretic Formulation of the Bootstrap Hypothesis—P. Kaus and F. Zachariasen. 171, 1597 (1968)
Wave Equations with Broken $U(3,1)$ Symmetry—Ernest E. H. Shin. 171, 1652 (1968)
Quantized Gauge Field Theory of Chiral Symmetry—York-Peng Yao. 171, 1702 (1968)
Subsidiary Condition in Quantum Electrodynamics—Kurt Haller and Leon F. Landovitz. 171, 1749 (1968)
Relativistic Lagrangian Field Theory for Composite Systems—Christian Fronsdal. 171, 1811 (1968)
Asymptotic Vertex Function in a Crossing-Symmetric Bootstrap Model of the Hadrons—John Harte. 171, 1825 (1968)
Possible Enhancement of Two-Photon-Exchange Effects in Large-Momentum-Transfer Electron-Proton Scattering—John Harte. 171, 1832 (1968)
Erratum: Quantum Theory of Gravity. I. The Canonical Theory—Bryce S. DeWitt. [160, 1113 (1967)] 171, 1834 (1968)
Erratum: Quantum Theory of Gravity. II. The Manifestly Covariant Theory—Bryce S. DeWitt. [162, 1195 (1967)] 171, 1834 (1968)
Erratum: Quantum Theory of Gravity. III. Applications of the Covariant Theory—Bryce S. DeWitt. [162, 1239 (1967)] 171, 1834 (1968)
Convergence of the Two-Component Plasma Correlation Function—Y. C. Lee, D. L. Lin, and Ta-You Wu. 172, 145 (1968)
Supplementary Conditions in the Quantized Gravitational Theory—Suraj N. Gupta. 172, 1303 (1968)
Local Field Theory and Isospin Invariance. III. Interactions of Self-Conjugate Isofermion Fields—P. Carruthers. 172, 1406 (1968)
Third Sector of the Lee Model—J. B. Bronzan. 172, 1429 (1968)
Covariant Version of the Bjorken Limit—P. Olesen. 172, 1461 (1968)
Systematic Renormalization Procedure for the $N$-Quantum Approximation—Arthur Halprin. 172, 1495 (1968)
General Form of Representations of the Current Algebra in the Two-Quark Model—Roger C. Hill. 172, 1521 (1968)
Nonexistence of Self-Conjugate Particles with Half-Integral Isospin—D. D. H. Yee. 172, 1537 (1968)
Canonical Representation of Sugawara's Theory—K. Bardakci and M. B. Halpern. 172, 1542 (1968)
Compositeness Conditions in Bronzan's Version of the Lee Model—P. S. Liossatos. 172, 1554 (1968)
Vector Fields and Current Commutators. II—David G. Boulware. 172, 1625 (1968)
Tree Graphs and Classical Fields—David G. Boulware and Lowell S. Brown. 172, 1628 (1968)
Dressed-Electron Stationary States in Quantum Electrodynamics—Gerald Rosen. 172, 1632 (1968)
Some Aspects of Field Symmetries—H. Scharfstein. 172, 1828 (1968)
Second Born Corrections to Wide-Angle High-Energy Electron Pair Production and Bremsstrahlung—Stanley J. Brodsky and John R. Gillespie. 173, 1011 (1968)
Properties of the Generalized Coherent State—Z. Bialynicka-Birula. 173, 1207 (1968)
Sources and Gravitons—Julian Schwinger. 173, 1264 (1968)
Wide-Angle Electron-Positron Pair Production. K. J. Cohen, S. Homma, D. Luckey, and L. S. Osborne. 173, 1339 (1968)
Theory of Currents, $\sigma$ Model, and the Spherical Top in the Internal Space—H. Sugawara and M. Yoshimura. 173, 1419 (1968)
Low-Energy-Theorem Approach to Single-Particle Singularities in the Presence of Massless Bosons—R. Jackiw and L. Soloviev. 173, 1485 (1968)
Soft Photons and the Classical Limit—Lowell S. Brown and Robert L. Goble. 173, 1505 (1968)
Coherent Soft-Photon States and Infrared Divergences. II. Mass-Shell Singularities of Green's Functions—T. W. B. Kibble. 173, 1527 (1968)
Relativistic Particle-Antiparticle Stationary States in a Model Quantum Field Theory: Mesons from Quarks—Gerald Rosen. 173, 1680 (1968)
Note on Nonlinear Realizations of Chiral Symmetry—William Sollfrey. 173, 1805 (1968)
Erratum: Application of $\xi$-Limiting Process to Intermediate Bosons—T. D. Lee. [128, 899 (1962)] 173, 1806 (1968)

**Lorentz Invariance, Local Field Theory, and Faster-than-Light Particles**—M. E. Arons and E. C. G. Sudarshan. 173, 1622 (1968)

**Resolution of the Runaway Problem for the Polaron**—S. L. Trubatch. 174, 1555 (1968)

**Axially Symmetric Zero-Mass Meson Solutions of Einstein Equations**—R. Penney. 174, 1578 (1968)

**Interaction Angular Momentum**—James H. Cooke. 174, 1602 (1968)

**Does Lorentz-Invariance Imply Causality?**—Michael M. Broido and John G. Taylor. 174, 1606 (1968)

**Quantum Electromagnetic Zero-Point Energy and Retarded Dispersion Forces**—Timothy H. Boyer. 174, 1631 (1968)

**Correlation between Transcendental and Polynomial Lagrangians**—H. M. Fried. 174, 1725 (1968)

**Scalar Fields Coupled to the Trace of the Energy-Momentum Tensor**—Peter G. O. Freund and Yoichiro Nambu. 174, 1741 (1968)

**Quantum Electromagnetic Zero-Point Energy of a Conducting Spherical Shell and the Casimir Model for a Charged Particle**—Timothy H. Boyer. 174, 1764 (1968)

**Quantum Field Theory of Interacting Tachyons**—J. Dhar and E. C. G. Sudarshan. 174, 1808 (1968)

**Calculation of the Sixth-Order Contribution from the Fourth-Order Vacuum Polarization to the Difference of the Anomalous Magnetic Moments of Muon and Electron**—B. E. Lautrup and E. de Rafael. 174, 1835 (1968)

**Coherent Soft-Photon States and Infrared Divergences. III. Asymptotic States and Reduction Formulas**—T. W. B. Kibble. 174, 1882 (1968)

**Dispersion Methods in the 2V Sector of the Lee Model**—Leonard M. Scarfone. 174, 1903 (1968)

**O(4) Symmetry of the Hydrogen Atom and the Lamb Shift**—Michael Lieber. 174, 2037 (1968)

**Radiative Correction to Pion Photoproduction**—Charles Picciotto and Allan S. Krass. 174, 2109 (1968)

**Erratum: Existence Proof by a Fixed-Point Theorem for Solutions of the Low Equation**—Robert L. Warnock. [170, 1323 (1968)] 174, 2169 (1968)

**Feynman Rules for Electromagnetic and Yang-Mills Fields from the Gauge-Independent Field-Theoretic Formalism**—Stanley Mandelstam. 175, 1580 (1968)

**Feynman Rules for the Gravitational Field from the Coordinate-Independent Field-Theoretic Formalism**—Stanley Mandelstam. 175, 1604 (1968)

**Coherent Soft-Photon States and Infrared Divergences. IV. The Scattering Operator**—T. W. B. Kibble. 175, 1624 (1968)

**Exact Calculation of Pair Production**—Ingjald Øverbø, Kjell J. Mork, and Haakon A. Olsen. 175, 1978 (1968)

**Equal-Time Commutators and Electromagnetic Mass Splittings**—David G. Boulware and S. Deser. 175, 1912 (1968)

**Electrodynamics with a Quantum of Length**—Kenneth W. Ford. 175, 2048 (1968)

**Transformation Properties and Relativistic Equations for Spin-One Elementary Systems**—L. Fonda and G. C. Ghirardi. 175, 2082 (1968)

**Currents as Coordinates in Nonrelativistic Quantum Mechanics**—W. J. Pardee, L. Schlessinger, and Jon Wright. 175, 2140 (1968)

**Erratum: Precise Theory of the Zeeman Spectrum for Atomic Hydrogen and Deuterium and the Lamb Shift**—Stanley J. Brodsky and Ronald G. Parsons. [163, 134 (1967)] 176, 423 (1968)

**Effect of the Anomalous Magnetic Moment of the Electron on the Nonlinear Lagrangian of the Electromagnetic Field**—R. F. O'Connell. 176, 1433 (1968)

**Emission of Radiation from a System of Many Excited Atoms**—V. Ernst and P. Stehle. 176, 1456 (1968)

**Exactly Soluble Nonrelativistic Model of Particles with Both Electric and Magnetic Charges**—Daniel Zwanziger. 176, 1480 (1968)

**Quantum Field Theory of Particles with Both Electric and Magnetic Charges**—Daniel Zwanziger. 176, 1489 (1968)

**Theories at Infinite Momentum**—K. Bardakci and M. B. Halpern. 176, 1686 (1968)

**Chiral Lagrangian Calculation of Pion-Nucleon Scattering Lengths**—R. D. Peccei. 176, 1812 (1968)

**Intersecting Regge Trajectories in a Field-Theory Model**—Arthur R. Swift. 176, 1848 (1968)

**Model Dependence of the Asymptotic Behavior of Form Factors for Relativistic Composite Models**—M. Ciafaloni. 176, 1898 (1968)

**Interacting Rarita-Schwinger Field**—Gyan Mohan. 176, 1931 (1968)

**A $\lambda\varphi^4$ Quantum Field Theory Without Cutoffs. I.** James Glimm and Arthur Jaffe. 176, 1945 (1968)

**Regge Asymptotic Behavior and the Bethe-Salpeter Equation**—Richard A. Brandt and Martin Feinroth. 176, 1985 (1968)

**Currents as Dynamical Variables**—Charles M. Sommerfield. 176, 2019 (1968)

**Lorentz Poles and Bethe-Salpeter Equations: Does an Infinite Number of Lorentz Poles Exist?**—N. P. Chang and R. P. Saxena. 176, 2101 (1968)

## 63 INTERACTIONS AND PROPERTIES (EXPERIMENT) (see also 61.2)

**Quasars and Quarks**—J. C. Huang and T. W. Edwards. 171, 1331 (1968)

**Search for Stable Fractionally Charged Particles**—David M. Rank. 176, 1635 (1968)

### 63.2 Weak

**Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$**—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)

**Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson**—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

**Interference between Neutral Kaons and Their Mass Difference**—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)

**Search for New Particles Produced by High-Energy Photons**—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)

**Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$**—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

**Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$**—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)

Experimental Study of the Decay $K_L^0 \to \pi + e + \nu$—S. H. Aronson and K. Wendell Chen. 175, 1708 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)

## 63.4 Electromagnetic

Quest for Faster-Than-Light Particles—Torsten Alväger and Michael N. Kreisler. 171, 1357 (1968)
1-BeV Electron Compton Scattering near 180°—B. Gittelman, W. C. Barber, W. Selove, D. Tompkins, and F. Forman. 171, 1388 (1968)
Scattering of High-Energy Positive and Negative Muons on Electrons—Thomas B. W. Kirk and Seth H. Neddermeyer. 171, 1412 (1968)
Positive Pion Photoproduction from Hydrogen for Incident Photon Energies 300–750 MeV—C. Betourne, J. C. Bizot, J. Perez-Y-Jorba, D. Treille, and W. Schmidt. 172, 1343 (1968)
Wide-Angle Electron-Positron Pair Production. K. J. Cohen, S. Homma, D. Luckey, and L. S. Osborne. 173, 1339 (1968)
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)
Experimental Upper Limit on the Magnetic Monopole Moment of Electrons, Protons, and Neutrons, Utilizing a Superconducting Quantum Interferometer—Lorin L. Vant-Hull. 173, 1412 (1968)
Proton Compton Effect by Polarized Photons at 90° in the c.m. System in the First Resonance Region—G. Barbiellini, G. Capon, G. De Zorzi, and G. P. Murtas. 174, 1665 (1968)
Photoproduction of Meson and Baryon Resonances at Energies up to 5.8 GeV—Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration. 175, 1669 (1968)
Proton-Proton Bremsstrahlung at 47 MeV—D. L. Mason, M. L. Halbert, and L. C. Northcliffe. 176, 1159 (1968)
Relativistic Energy Loss by Ionization in Nuclear Emulsions—F. J. Congel and P. J. McNulty. 176, 1615 (1968)
Search for the Electroproduction of the $N^*(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)
Search for the Contribution of the Longitudinal Virtual Photon in Inelastic Electron-Proton Scattering—Paul Bounin. 176, 1643 (1968)
Experimental Tests of Cascade Theory at High Energies—R. Holynski, W. V. Jones, and K. Pinkau. 176, 1661 (1968)
Erratum: Ionization Loss at Relativistic Velocities—C. A. Nicoletta, P. J. McNulty, and P. L. Jain. [164, 1693 (1967)] 176, 2167 (1968)

## 63.6 Strong —— Induced by Baryons (see also 52.6)

Measurements of $C_{NN}$ in Proton-Proton Scattering from 305 to 415 MeV—A. Beretvas. 171, 1392 (1968)
Observation of $Y^{*+}(1385)K^+$ and $N^{*+}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)
Strange-Particle Production in 8-BeV/$c$ Proton-Proton Interactions—M. Firebaugh, G. Ascoli, E. L. Goldwasser, R. D. Sard, and J. Wray. 172, 1354 (1968)
Determination of the Nucleon-Nucleon Scattering Matrix. IX. $(\pi,p)$ Analysis from 7 to 750 MeV—Malcolm H. MacGregor, Richard A. Arndt, and Robert M. Wright. 173, 1272 (1968)
Pion Production and Elastic Scattering in Antiproton-Proton Collisions at 6.94 BeV/$c$—T. Ferbel, J. A. Johnson, H. I. Kraybill, J. Sandweiss, and H. D. Taft. 173, 1307 (1968)
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)
Study of the $\Lambda$-$N$ System in Low-Energy $\Lambda$-$p$ Elastic Scattering—G. Alexander, U. Karshon, A. Shapira, G. Yekutieli, R. Engelmann, H. Filthuth, and W. Lughofer. 173, 1452 (1968)
Proton-Proton Elastic Scattering between 6 and 10 MeV—R. J. Slobodrian, H. E. Conzett, E. Shield, and W. F. Tivol. 174, 1122 (1968)
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)
Proton-Neutron Triple Scattering at 425 MeV. I.—S. C. Wright, D. Shawhan, L. Pondrom, S. Olsen, and R. Handler. 175, 1704 (1968)
Low-Energy $\Lambda$-Proton Elastic Scattering—B. Sechi-Zorn, B. Kehoe, J. Twitty, and R. A. Burnstein. 175, 1735 (1968)
Proton-Proton Bremsstrahlung at 47 MeV—D. L. Mason, M. L. Halbert, and L. C. Northcliffe. 176, 1159 (1968)
Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/$c$—A. Fridman, G. Maurer, A. Michalon, J. Oudet, R. Straub, C. Voltolini, and P. Cüer. 176, 1595 (1968)
Nucleon-Nucleon Models, Charge Splitting, and the Nucleon-Nucleon Data near 210 MeV—M. D. Miller, P. S. Signell, and N. R. Yoder. 176, 1724 (1968)

## 63.8 Strong —— Induced by Mesons (see also 52.5)

Search for a $2\pi^0$ Resonance near 730 MeV in $\pi^+ d$ Interactions—Gerald A. Smith and Robert J. Manning. 171, 1399 (1968)
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)
Two-Prong Interaction by $\pi^+ + p$ Collisions at 2.77 BeV/$c$—S. S. Yamamoto and D. C. Rahm. 173, 1302 (1968)
Charge-Exchange Scattering of $K^+$ Mesons from Beryllium at 0.97 BeV/$c$—J. Gezelter, G. L. Salmon, F. V. Murphy, G. K. O'Neill, and R. Grismore. 173, 1315 (1968)
Reactions $K^- p \to \Sigma^\pm \pi^\mp$ at 4.07 and 5.47 GeV/$c$—J. S. Loos, U. E. Kruse, and E. L. Goldwasser. 173, 1330 (1968)
$\pi^- p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)
Single-Proton Emission Following Positive Pion Absorption in Carbon—T. R. Witten, M. Blecher, and K. Gotow. 174, 1166 (1968)
Spin-Parity Analysis of the Low-Mass (1.1–1.4 BeV) $K^+\pi$ System in $K^- p \to \bar{K}^{*0} \pi^- p$ at 5.5 BeV/$c$—J. C. Park and S. Kim. 174, 2165 (1968)

Final States with Two or More Strange Particles from 4.25-BeV/$c$ $K^-p$ Interactions—G. S. Abrams, R. G. Glasser, B. Kehoe, B. Sechi-Zorn, and G. Wolsky. 175, 1697 (1968)

Two-Charged-Particle Final States of $K^-p$ Interactions at 2.63 and 2.70 GeV/$c$—J. R. Ficenec, H. A. Gordon, and W. P. Trower. 175, 1725 (1968)

Search for a Strange Boson of Mass Less than 670 MeV—Lawrence Kirsch. 175, 1733 (1968)

$\pi^-p \to \pi^-\pi^0 p$ Reaction at 2.77 GeV/$c$ for Low Momentum Transfers to the Proton—J. P. Baton and G. Laurens. 176, 1574 (1968)

$K^*(890)$ and $K^*(1420)$ Production in $K^-p$ Interactions at 4.57 BeV/$c$—Y. W. Kang. 176, 1587 (1968)

$\bar{K}^0$ and $\Lambda^0$ Production in $K^- + p$ Interactions at 7.7 GeV/$c$—A. Buffington and C. E. W. Ward. 176, 1621 (1968)

Charge-Exchange $K^- + p \to \bar{K}^0 + n$ at 7.7 GeV/$c$—A. Buffington, D. H. Frisch, and C. E. W. Ward. 176, 1628 (1968)

$K^-p$ Elastic Scattering at 4.6 GeV/$c$—L. S. Schroeder, R. A. Leacock, R. L. Wagstaff, and W. J. Kernan. 176, 1648 (1968)

Compilation of $\pi^-p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

## 64 INTERACTIONS AND PROPERTIES (THEORY)

Quantized Gauge Field Theory of Chiral Symmetry—York-Peng Yao. 171, 1702 (1968)

Nonlocal Currents as Coordinates for Particles—J. Šoln. 171, 1773 (1968)

Vector Fields and Current Commutators. II—David G. Boulware. 172, 1625 (1968)

Large-Angle Scattering and the Fifth Interaction—Y. Ne'eman 172, 1818 (1968)

Feynman Rules for the Gravitational Field from the Coordinate-Independent Field-Theoretic Formalism—Stanley Mandelstam. 175, 1604 (1968)

### 64.2 Weak

$A_1$-$\rho$-$\pi$ System and $\pi \to l\nu\gamma$ Decay—Riazuddin and Fayyazuddin. 171, 1428 (1968)

Theoretical Study of $K_{l_4}$ Decay—F. A. Berends, A. Donnachie, and G. C. Oades. 171, 1457 (1968)

Parity-Conserving Hyperon Nonleptonic Decays in $SU(3)$—M. O. Taha. 171, 1481 (1968)

Second-Order Weak Processes and Weak-Interaction Cutoff—R. N. Mohapatra, J. Subba Rao, and R. E. Marshak. 171, 1502 (1968)

Nonleptonic Decays of Hyperons and Current Algebra—Francis C. P. Chan. 171, 1543 (1968)

Vector and Axial-Vector Meson Dominance in the $K_{3\pi}$ Decays—R. H. Graham and S. K. Yun. 171, 1550 (1968)

Renormalization of Weak Form Factors, and the Cabibbo Angle—H. R. Quinn and J. D. Bjorken. 171, 1660 (1968)

$\Delta I = \frac{1}{2}$ Rule in Current-Current Models of $CP$ Violation—Barry R. Holstein. 171, 1668 (1968)

Radiative Corrections to $K_{e3}{}^0$ Decays and the $\Delta I = \frac{1}{2}$ Rule—Edward S. Ginsberg. 171, 1675 (1968)

Lewis-Oppenheimer-Wouthuysen Model Applied to Neutrino Reactions—Barbara Sakitt. 171, 1715 (1968)

Intermediate Bosons and the Electromagnetic Field—T. D. Lee. 171, 1731 (1968)

$K_{l3}$-Decay Form Factors, Current Algebra, and Subtracted Dispersion Relations. II—Norman H. Fuchs. 172, 1532 (1968)

$\kappa$-Meson Mass and Weak-Decay Parameters from a Study of $K_{l3}$ Form Factors—Jacob E. Mackey, J. Michael McKisic, David M. Scott, and Walter W. Wada. 172, 1590 (1968)

Final-State Interactions in the $K \to 3\pi$ and $\eta \to 3\pi$ Decays—Michael Parkinson. 172, 1607 (1968)

Determination of Cabibbo Parameters from Baryon Decays—H. T. Nieh and Michael Martin Nieto. 172, 1694 (1968)

Possible Weak Interaction of Photons and Emission of Neutrinos from Stars—Pratul Bandyopadhyay. 173, 1481 (1968)

Radiative Pion Capture and the Pion-Nucleus Vertex Function—David Griffiths and C. W. Kim. 173, 1584 (1968)

Some Remarks about Dynamical Asymmetry—A. Pais. 173, 1587 (1968)

Current Commutators and Electromagnetic Mass Differences—John M. Cornwall and R. E. Norton. 173, 1637 (1968)

Models of Weak Interactions Mediated by Vector Bosons—G. Segrè. 173, 1730 (1968)

Ratio of Axial-Vector to Vector Contributions in $K \to l\nu\gamma$ Decay—A. Q. Sarker. 173, 1749 (1968)

$K_{l3}$ Form Factors in Current Algebra with Hard Pion and Kaon—Riazuddin and A. Q. Sarker. 173, 1752 (1968)

Structure-Dependent Axial-Vector Form Factor in Charged-Pion Radiative Decay—J. S. Vaishya. 173, 1757 (1968)

Erratum: Application of $\xi$-Limiting Process to Intermediate Bosons—T. D. Lee. [128, 899 (1962)] 173, 1806 (1968)

Weak Parity-Nonconserving Potentials—D. Tadić. 174, 1694 (1968)

Effect of a Degenerate Neutrino Sea on Electromagnetism—J. Royer. 174, 1719 (1968)

Method of Calculating the Axial-Vector Current Coupling Constants for Lepton Decays of Baryons—M. K. Au-Yang. 174, 1731 (1968)

Current Algebra on the Mass Shell: Leptonic $K$ Decays—David F. Greenberg. 174, 1820 (1968)

Phenomenological Chiral Model for Nonleptonic Hyperon Decays—Joseph Schechter. 174, 1829 (1968)

Sum Rules for Weak $BB\pi$ Amplitudes—E. Fischbach and K. Trabert. 174, 1843 (1968)

Pole Models for $S$-Wave Hyperon Decay—D. S. Carlstone, S. P. Rosen, and S. Pakvasa. 174, 1877 (1968)

Current Commutation Relations in $R(11)$—L. L. Smalley and D. W. Joseph. 174, 1937 (1968)

$W^+$-Meson Production—W. Williamson, Jr., and R. T. Deck. 174, 1986 (1968)

Once-Subtracted Dispersion Relations, Current Algebra, and $K_{l3}$ Form Factors—J. C. Pati and K. J. Sebastian. 174, 2033 (1968)

Hard-Kaon Processes and the Spectral-Function Sum Rules—Yoshiaki Ueda. 174, 2082 (1968)

Weak $\eta$ Production and the Existence of Second-Class Currents—Norman Dombey. 174, 2127 (1968)

Structure of the Nonleptonic Weak Interactions of Mesons—Giovanni Venturi. 174, 2154 (1968)

Erratum: Radiative Corrections to $K_{e3}{}^0$ Decays and the $\Delta I = \frac{1}{2}$ Rule—Edward S. Ginsberg. [171, 1675 (1968)] 174, 2169 (1968)

Model Dependence of Corrections to the Fermi Function and $ft$ Values of Some $0^+ \to 0^+$ Super-Allowed $\beta$ Decays, and the Value of the Vector Coupling Constant—T. A. Halpern and B. Chern. 175, 1314 (1968)

Static Coulomb Corrections to the Point-Nucleus Fermi Function in Nuclear Beta Decay—L. J. Logue and B. Chern. 175, 1367 (1968)

Momentum-Dependent $K_{\ell 4}$-Decay Form Factors—Ranabir Dutt, K. C. Gupta, and J. S. Vaishya. 175, 1884 (1968)

Ultraviolet Divergences in Radiative Corrections to Weak Decays—Giuliano Preparata and William I. Weisberger 175, 1965 (1968)

Spectrum Correction Factors in $\eta$, $K \to 3\pi$ Decay—Brian G. Kenny. 175, 2054 (1968)

Stress-Tensor–Current Commutators, Electromagnetic and Weak Corrections to Current Commutators, and Sum Rules—R. Jackiw. 175, 2058 (1968)

Final-State Interactions in $\eta \to 3\pi$ and $K_2^0 \to 3\pi$ Decays—R. N. Chaudhuri. 175, 2066 (1968)

Asymptotic Behavior of the $\pi$-Point Function and Some Applications—P. Olesen. 175, 2165 (1968)

Current-Current Interaction and Calculation of the Nonleptonic Baryon Decays—Shmuel Nussinov and Giuliano Preparata. 175, 2180 (1968)

Phenomenological Analysis of Weak-Radiative Decay of the $K^+$ Meson and $CP$-Noninvariant Effects—Y. Singh. 175, 2214 (1968)

Renormalization of the Strangeness-Changing Axial-Vector Coupling Constants—C. H. Chan and F. T. Meiere. 175, 2222 (1968)

Erratum: Sum Rules for the Axial-Vector Coupling Constant Renormalization in $\beta$ Decay—Stephen L. Adler. [140, B736 (1965); 142, 1294(E) (1966)]. 175, 2224 (1968)

Nuclear Effects on the Quasi-Elastic Neutrino Scattering $\nu+n \to \mu^-+p$—York-Peng Yao. 176, 1680 (1968)

$CP$ Violation and Coherent Decays of Kaon Pairs—Harry J. Lipkin. 176, 1715 (1968)

Can the Parity of the $\Omega^-$ Be Measured?—G. L. Kane and Michael J. Moravcsik. 176, 1733 (1968)

Structure in $\eta$, $K \to 3\pi$ Decay—Brian G. Kenny. 176, 1735 (1968)

Decays of Odd-Parity Baryon Resonances—J. C. Carter and M. E. M. Head. 176, 1808 (1968)

Relation of Charged-$K$ Decay to $CP$ Violation—Robert M. Delaney and Daniel J. Welling. 176, 1841 (1968)

Model for Leptonic Interactions. II. Is the Pion the Intermediate Boson?—Christian Fronsdal. 176, 1846 (1968)

Divergent Part of the Second-Order Electromagnetic Corrections to the Ratio $G_A/G_V$—A. Sirlin. 176, 1871 (1968)

$K_{l4}$ Form Factors in Current Algebra with Hard Pions and Kaon—A. Q. Sarker. 176, 1959 (1968)

Current Algebra and the Vector Form Factor in $K_{l4}$ Decays—A. Q. Sarker. 176, 1971 (1968)

Study of the Decays $K \to l\bar{l}$ and $K \to \pi l\bar{l}$—A. Pais and S. B. Treiman. 176, 1974 (1968)

Scalar Nonet, Semileptonic $K$ Decays, and Spectral-Function Sum Rules—Binayak Dutta-Roy and Alexander Martin. 176, 1979 (1968)

Renormalizable Theory of the Weak Interactions—N. Christ. 176, 2086 (1968)

$K \to 2\pi$ Phenomenology with Small $CP$ Nonconservation—L. David Roper. 176, 2120 (1968)

## 64.4 Electromagnetic

Wave Equations on a Hyperplane—C. L. Hammer, S. C. McDonald, and D. L. Pursey. 171, 1349 (1968)

$A_1$-$\rho$-$\pi$ System and $\pi \to l\nu\gamma$ Decay—Riazuddin and Fayyazuddin. 171, 1428 (1968)

Kinematical Singularities and Zeros for the Reaction $\gamma N \to VN$—E. Gotsman and U. Maor. 171, 1495 (1968)

Multiple Soft-Pion Production—A. N. Kamal. 171, 1556 (1968)

Consequences of the Modified Hypothesis of Partially Conserved Axial-Vector Current in Photopion Production—M. L. Tapper. 171, 1561 (1968)

Form Factors and Electromagnetic Masses—Tung-mow Yan. 171, 1613 (1968)

Incoherent-Scattering Function, Total Pair-Production Cross Section, and Pair-Production Length for Helium—T. M. Knasel. 171, 1643 (1968)

$\rho^+$ Photoproduction and $\pi^+$ Production via $\rho^+$ Regge-Trajectory Exchange—Charles Picciotto. 171, 1648 (1968)

Inelastic Contribution to the $p$-$n$ Mass Difference in Cottingham's Formula—Taizo Muta. 171, 1661 (1968)

Radiative Corrections to $K_{\ell 3}^0$ Decays and the $\Delta I=\frac{1}{2}$ Rule—Edward S. Ginsberg. 171, 1675 (1968)

Emission of Low-Energy Photons in Scattering and Decay Processes and a Possible Method for Determining Electromagnetic Properties of Short-Lived States—Saul Barshay and Tsu Yao. 171, 1708 (1968)

Intermediate Bosons and the Electromagnetic Field—T. D. Lee. 171, 1731 (1968)

Sum Rules from Charge–Charge-Density and Charge–Charge Commutators—S. Matsuda and S. Oneda. 171, 1743 (1968)

Subsidiary Condition in Quantum Electrodynamics—Kurt Haller and Leon F. Landovitz. 171, 1749 (1968)

Pion Conspiracy and Pion Residue from the Finite-Energy Photoproduction Sum Rule—D. P. Roy and Shu-Yuan Chu. 171, 1762 (1968)

Optical-Model Analysis of Pion-Nucleus Scattering. II. Pion Form Factor—E. H. Auerbach, D. M. Fleming, and M. M. Sternheim. 171, 1781 (1968)

Determination of the Electromagnetic Couplings of the $\rho$ and $A_1$ Mesons—P. De Baenst and J. Pestieau. 171, 1805 (1968)

Possible Enhancement of Two-Photon-Exchange Effects in Large-Momentum-Transfer Electron-Proton Scattering—John Harte. 171, 1832 (1968)

Electromagnetic Mass Differences and Regge Phenomenology—David J. Gross and Heinz Pagels. 172, 1381 (1968)

Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: General Features—P. Babu, S. Frautschi, and N. S. Thornber. 172, 1389 (1968)

Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: Detailed Calculation—N. S. Thornber. 172, 1395 (1968)

Coulomb Interference in High-Energy Scattering—Geoffrey B. West and D. R. Yennie. 172, 1413 (1968)

Tests for $|\Delta I| \leq 1$ in Electromagnetic Interactions—Ernest E. Bergmann. 172, 1441 (1968)

Scalar- and Tensor-Tadpole Contribution to $K^0$-$K^+$ Mass Difference—Sharashchandra H. Patil. 172, 1528 (1968)

Final-State Interactions in the $K \to 3\pi$ and $\eta \to 3\pi$ Decays—Michael Parkinson. 172, 1607 (1968)

Broken $SU(3)$ Symmetry, Sum Rules, and the Magnetic Moments of the Baryons—T. P. Cheng and Heinz Pagels. 172, 1635 (1968)

Pion Electromagnetic Form Factor—Tran N. Truong, R. Vinh Mau, and Pham xuan Yem. 172, 1645 (1968)

Inelastic Electron Scattering in the Symmetric Quark Model. II. Coulomb Potential—N. S. Thornber. 173, 1414 (1968)

Invariant Amplitudes for Photon Processes—W. A. Bardeen and Wu-Ki Tung. 173, 1423 (1968)

Pomeranchuk Theorem for Partial Waves and Narrowing of Resonance Widths: The $\rho$ Meson—Bipin R. Desai and David T. Gregorich. 173, 1434 (1968)

Low-Energy-Theorem Approach to Single-Particle Singularities in the Presence of Massless Bosons—R. Jackiw and L. Soloviev. 173, 1485 (1968)

Soft Photons and the Classical Limit—Lowell S. Brown and Robert L. Goble. 173, 1505 (1968)

Field-Current Identities and Nucleon Radii—M. A. B. Bég, J. Bernstein, and M. Tausner. 173, 1523 (1968)

Sources and Magnetic Charge—Julian Schwinger. 173, 1536 (1968)

Asymptotic Behavior of Form Factors for Some Composite Models—M. Ciafaloni and P. Menotti. 173, 1575 (1968)

Radiative Pion Capture and the Pion-Nucleus Vertex Function—David Griffiths and C. W. Kim. 173, 1584 (1968)

Some Remarks about Dynamical Asymmetry—A. Pais. 173, 1587 (1968)

Asymptotic Behavior of Amplitudes for Meson Photoproduction—H. G. Dosch. 173, 1595 (1968)

Anomalous Nuclear Photoproduction of $\phi$ Mesons—J. S. Trefil. 173, 1629 (1968)

Current Commutators and Electromagnetic Mass Differences—John M. Cornwall and R. E. Norton. 173, 1637 (1968)

Anomalous Magnetic Moment of the $A_1$—V. S. Mathur and R. N. Mohapatra. 173, 1668 (1968)

Threshold Electropion Production from Current Algebra and Partially Conserved Axial-Vector Current—A. M. Gleeson, M. G. Gundzik, and Jacob G. Kuriyan. 173, 1708 (1968)

Ratio of Axial-Vector to Vector Contributions in $K \to l\nu\gamma$ Decay—A. Q. Sarker. 173, 1749 (1968)

Two-Pole Model for the $\eta_{3\pi}$ Decays—Suk Koo Yun. 173, 1764 (1968)

Erratum: Application of $\xi$-Limiting Process to Intermediate Bosons—T. D. Lee. [128, 899 (1962)] 173, 1806 (1968)

Erratum: Reggeization of External Particles—M. L. Thiebaux. [170, 1244 (1968)] 173, 1806 (1968)

Soft-Photon Theorem for Bremsstrahlung in a Potential Model—Leon Heller. 174, 1580 (1968)

Electromagnetic Properties of Baryons in a Quark-Diquark Model with Broken $SU(6)$—James Carroll, D. B. Lichtenberg, and J. Franklin. 174, 1681 (1968)

Bjorken Limit and Pole Dominance. I. The $\omega\rho\pi$ System and the Algebra of Fields—Stanley G. Brown and Geoffrey B. West. 174, 1777 (1968)

Bjorken Limit and Pole Dominance. II. Virtual $\pi\rho$ Scattering—Stanley G. Brown and Geoffrey B. West. 174, 1786 (1968)

Decay Mode $\Sigma^0 \to \Lambda^0+\gamma+\gamma$ and the Magnetic Moment of the $\Sigma^0$—H. S. Mani and York-Peng Yao. 174, 1797 (1968)

Rare Decay Mode $\eta \to \pi^+\pi^-\pi^0\gamma$ and the Relation between Vector-Dominance and Current-Algebra Calculations—Aruna Chatterjee. 174, 1832 (1968)

Calculation of the Sixth-Order Contribution from the Fourth-Order Vacuum Polarization to the Difference of the Anomalous Magnetic Moments of Muon and Electron—B. E. Lautrup and E. de Rafael. 174, 1835 (1968)

Pion Form-Factor Zero and "Dipole" Nucleon Structure—J. J. Brehm and L. F. Cook. 174, 1901 (1968)

Kinematical Constraints on Helicity Amplitudes—Jeffrey E. Mandula. 174, 1948 (1968)

$T$-Violation Effects and Final-State Interactions—G. Karpman, R. Leonardi, and F. Strocchi. 174, 1957 (1968)

Current Algebra and Double-Pion Photoproduction—S. C. Bhargava. 174, 1969 (1968)

$W^+$-Meson Production—W. Williamson, Jr., and R. T. Deck. 174, 1986 (1968)

Electromagnetic Interactions of Loosely-Bound Composite Systems—Stanley J. Brodsky and Joel R. Primack. 174, 2071 (1968)

Radiative Correction to Pion Photoproduction—Charles Picciotto and Allan S. Krass. 174, 2109 (1968)

Erratum: Radiative Corrections to $K_{e3}^0$ Decays and the $\Delta I=\frac{1}{2}$ Rule—Edward S. Ginsberg. [171, 1675 (1968)] 174, 2169 (1968)

Erratum: Threshold Electrodisintegration of the Deuteron—Ronald J. Adler. [169, 1192 (1968)] 174, 2169 (1968)

Static Coulomb Corrections to the Point-Nucleus Fermi Function in Nuclear Beta Decay—L. J. Logue and B. Chern. 175, 1367 (1968)

Feynman Rules for Electromagnetic and Yang-Mills Fields from the Gauge-Independent Field-Theoretic Formalism—Stanley Mandelstam. 175, 1580 (1968)

High-Energy Polarized-Photon Reactions—Robert L. Thews. 175, 1749 (1968)

Vertex-Strength-Algebra Treatment of Vector-Meson Photoproduction—A. C. Hirshfeld and L. P. Horwitz. 175, 1865 (1968)

Corrections to the Coleman-Glashow Sum Rule—Stephen Brook Fels. 175, 1895 (1968)

Prediction for the Reaction $\pi N \to \pi N^*$ Based on a Partially Conserved Axial-Vector Current—M. E. Arons. 175, 1905 (1968)

Equal-Time Commutators and Electromagnetic Mass Splittings—David G. Boulware and S. Deser. 175, 1912 (1968)

Determination of the Pion Form Factor by Electroproduction of Pions—K. F. Lambrakos and T. A. Griffy. 175, 1948 (1968)

Pion Photoproduction and Fixed-$t$ Dispersion Relations—J. Engels, A. Müllensiefen, and W. Schmidt. 175, 1951 (1968)

Ultraviolet Divergences in Radiative Corrections to Weak Decays—Giuliano Preparata and William I. Weisberger 175, 1965 (1968)

Exact Calculation of Pair Production—Ingjald Øverbø, Kjell J. Mork, and Haakon A. Olsen. 175, 1978 (1968)

Determination of the Isotensor Electromagnetic Current from Pion Photoproduction—B. Gittelman and W. Schmidt. 175, 1998 (1968)

Pion Photoproduction, $NN$ Scattering, and Photoproduction Sum Rules—Richard C. Brower and Jan W. Dash. 175, 2014 (1968)

$SU(6)_W$ and High-Energy Photoproduction—S. Meshkov and R. Ponzini. 175, 2030 (1968)

Stress-Tensor–Current Commutators, Electromagnetic and Weak Corrections to Current Commutators, and Sum Rules—R. Jackiw. 175, 2058 (1968)

Final-State Interactions in $\eta \to 3\pi$ and $K_2^0 \to 3\pi$ Decays—R. N. Chaudhuri. 175, 2066 (1968)

Current Algebra and $K^+\Lambda$ Photoproduction—Debabrata Basu and R. N. Chaudhuri. 175, 2075 (1968)

Quark Interactions and Nucleon Form Factors—G. M. Cicuta, G. Marchesini, and A. Scotti. 175, 2113 (1968)

"Non-Abelian Compton Effect" on Spin-One Targets—Arvind Kumar. 175, 2148 (1968)

Asymptotic Behavior of the $n$-Point Function and Some Applications—P. Olesen. 175, 2165 (1968)

Current-Current Interaction and Calculation of the Nonleptonic Baryon Decays—Shmuel Nussinov and Giuliano Preparata. 175, 2180 (1968)

Continuous-Moment Sum Rules and Pion Conspiracy in Photoproduction—K. Raman and Kashyap V. Vasavada. 175, 2191 (1968)

Phenomenological Analysis of Weak-Radiative Decay of the $K^*$ Meson and $CP$-Noninvariant Effects—Y. Singh. 175, 2214 (1968)

Quantum Theory of an Electron Gas with Anomalous Magnetic Moments in Intense Magnetic Fields—Hong-Yee Chiu, Vittorio Canuto, and Laura Fassio-Canuto. 176, 1438 (1968)
Exactly Soluble Nonrelativistic Model of Particles with Both Electric and Magnetic Charges—Daniel Zwanziger. 176, 1480 (1968)
Relativistic Corrections to Nonrelativistic Two-Particle Dynamical Calculations: Demonstration of the Validity of the Drell-Hern-Gerasimov Sum Rule for Weakly Bound Composite Particles—Hugh Osborn. 176, 1523 (1968)
Low-Energy Theorems for $e^4$ Compton Scattering Amplitudes—T. P. Cheng. 176, 1674 (1968)
Divergent Part of the Second-Order Electromagnetic Corrections to the Ratio $G_A/G_V$—A. Sirlin. 176, 1871 (1968)
Study of the Decays $K \to l\bar{l}$ and $K \to \pi l\bar{l}$—A. Pais and S. B. Treiman. 176, 1974 (1968)
Model Dependence of the Asymptotic Behavior of Form Factors for Relativistic Composite Models—M. Ciafaloni. 176, 1898 (1968)
$K^*(890)$ Photoproduction in the Regge-Pole Model—N. S. Thornber. 176, 1998 (1968)
Cancellation of Divergences in Reggeized Electromagnetic Mass Differences—Arnulf Rabl. 176, 2034 (1968)
Model of High-Energy Meson Photoproduction—T. T. Chou. 176, 2041 (1968)
Virtual-Photon–Pion Scattering, Hard-Pion Current Algebra and Dispersion Relations—K. C. Gupta and J. S. Vaishya. 176, 2125 (1968)
Compton Scattering by Spin-One Particles—Wu-Ki Tung. 176, 2127 (1968)
Low-Energy Compton Scattering by Arbitrary-Spin Targets—Ira J. Kalet. 176, 2135 (1968)
Erratum: Current Algebra and Photoproduction of Pions—M. S. Bhatia and P. Narayanaswamy. [172, 1742 (1968)] 176, 2167 (1968)

## 64.6 Strong (General)

Complex Angular Momentum and Infinite Helicity Sums. II—G. A. Winbow. 171, 1517 (1968)
Centrifugal-Barrier Effects in $N/D$ Calculations—R. W. Childers and A. W. Martin. 171, 1540 (1968)
Multiple Soft-Pion Production—A. N. Kamal. 171, 1556 (1968)
Consequences of the Modified Hypothesis of Partially Conserved Axial-Vector Current in Photopion Production—M. L. Tapper. 171, 1561 (1968)
Field-Theoretic Formulation of the Bootstrap Hypothesis—P. Kaus and F. Zachariasen. 171, 1597 (1968)
Form Factors and Electromagnetic Masses—Tung-mow Yan. 171, 1613 (1968)
Two Simple Approximation Schemes for Lippmann-Schwinger–Type Equations—L. A. P. Balázs and Sharashchandra H. Patil. 171, 1633 (1968)
$\rho^+$ Photoproduction and $\pi^+$ Production via $\rho^+$ Regge-Trajectory Exchange—Charles Picciotto. 171, 1648 (1968)
Conspiracy Relations for Unequal-Mass Processes—John D. Stack. 171, 1666 (1968)
Lewis-Oppenheimer-Wouthuysen Model Applied to Neutrino Reactions—Barbara Sakitt. 171, 1715 (1968)
Approximate Bounds on Coupling Constants from Analyticity, Crossing, and Unitarity—D. Atkinson and F. Calogero. 171, 1767 (1968)
A Sum Rule Based on Unitarity—Farzam Arbab and Richard C. Slansky. 171, 1785 (1968)
Enhancement of $SU(3)$ Breakings and Regge Trajectories—Mahiko Suzuki. 171, 1791 (1968)
Pion Production, Current Algebra, and Coupling-Constant Relations—A. N. Mitra and R. Nath. 171, 1798 (1968)
Asymptotic Vertex Function in a Crossing-Symmetric Bootstrap Model of the Hadrons—John Harte. 171, 1825 (1968)
Erratum: Construction of Solutions to Superconvergence Relations—D. Atkinson and M. B. Halpern. [166, 1724 (1968)] 171, 1834 (1968)
Electromagnetic Mass Differences and Regge Phenomenology—David J. Gross and Heinz Pagels. 172, 1381 (1968)
Quark Model and Masses of Baryons and Mesons—S. P. Misra and C. V. Sastry. 172, 1402 (1968)
Coulomb Interference in High-Energy Scattering—Geoffrey B. West and D. R. Yennie. 172, 1413 (1968)
Diffractive $2\pi$ Production and $\pi$-$\pi$ Interactions—S. Nussinov. 172, 1446 (1968)
Bounds for Coupling Constants in the Multi-Regge Model—K. Kajantie. 172, 1470 (1968)
Paraquarks, Structural Saturation, and Hard Core—A. N. Mitra and S. A. Moszkowski. 172, 1474 (1968)
Parity Doubling for Bosons and $M=1$ Propagators—V. A. Alessandrini. 172, 1503 (1968)
Canonical Representation of Sugawara's Theory—K. Bardakci and M. B. Halpern. 172, 1542 (1968)
Determination of Vacuum Regge Poles and Cuts—Terence W. Rogers and John H. Schwarz. 172, 1595 (1968)
Pion Electromagnetic Form Factor—Tran N. Truong, R. Vinh Mau, and Pham xuan Yem. 172, 1645 (1968)
Bootstrap Calculation of Vector-Meson–Baryon Coupling Constants—G. L. Kane and W. F. Palmer. 172, 1648 (1968)
Reaction Amplitudes for Pseudoscalar Mesons on Spin-$\frac{1}{2}$ Fermions in Fourth-Order Perturbation Theory—Joseph J. Kubis and John L. Gammel. 172, 1664 (1968)
Conspirators and Daughters in Unequal-Mass, Nonzero-Spin Scattering—Matthew A. Jacobs and Mark H. Vaughn. 172, 1677 (1968)
Static $SU(6)$ and Fundamental Substitution—Shin Ishida and P. Roman. 172, 1684 (1968)
Bootstrap Solutions of the Bethe-Salpeter Equation—William B. Kaufmann. 172, 1697 (1968)
Reggeization of Quark Number—R. Delbourgo, Abdus Salam, and J. Strathdee. 172, 1727 (1968)
Current Algebra and Photoproduction of Pions—M. S. Bhatia and P. Narayanaswamy. 172, 1742 (1968)
Model for Pion $S$-Wave Phase Shifts from Current Algebra and Partial Conservation of Axial-Vector Current—A. M. S. Amatya, A. Pagnamenta, and B. Renner. 172, 1755 (1968)
Stationary Expectation Values and Slopes of Daughter Regge Trajectories for the Bethe-Salpeter Equation—Rabinder N. Madan, Richard W. Haymaker, and R. Blankenbecler. 172, 1788 (1968)
Impact Parametrization of the Scattering Amplitude—Ngee-Pong Chang. 172, 1796 (1968)
A Model of Baryons Made of Quarks with Hidden Spin—Jerrold Franklin. 172, 1807 (1968)
Simultaneous "Partial-Wave" Expansion in the Mandelstam Variables: Crossing Symmetry for Partial Waves—A. P. Balachandran and J. Nuyts. 172, 1821 (1968)
Two-Pion-Exchange Theory. Nucleon-Nucleon Scattering—P. C. M. Yock. 172, 1844 (1968)
Theory of Currents, $\sigma$ Model, and the Spherical Top in the Internal Space—H. Sugawara and M. Yoshimura. 173, 1419 (1968)
Unitarity and the Mandelstam Representation. II. Large-Angular-Momentum Partial-Wave Amplitudes—Arthur W. Martin. 173, 1439 (1968)

**Strongly Decaying Particles and Relativistic Invariance**—François Lurçat. 173, 1461 (1968)

**Analytic Continuation of Divergent Integrals with Respect to a Parameter—The Case of Perturbations to Strong Interactions**—Mahiko Suzuki. 173, 1473 (1968)

**Statistical Model for High-Energy Reactions**—L. L. Foldy, H. Kottler, D. R. Speiser, and J. Weyers. 173, 1517 (1968)

**Field-Current Identities and Nucleon Radii**—M. A. B. Bég, J. Bernstein, and M. Tausner. 173, 1523 (1968)

**Analytic Properties of Current-Algebra Vertex Functions**—Myron Bander. 173, 1568 (1968)

**Some Remarks about Dynamical Asymmetry**—A. Pais. 173, 1587 (1968)

**Asymptotic Behavior of Amplitudes for Meson Photoproduction**—H. G. Dosch. 173, 1595 (1968)

**Multiple Scattering in the Quark Model**—David R. Harrington and Antonio Pagnamenta. 173, 1599 (1968)

**Anomalous Nuclear Photoproduction of $\phi$ Mesons**—J. S. Trefil. 173, 1629 (1968)

**Equal-Mass Conspiracy Relations as the Limit of the Unequal-Mass Case**—John D. Stack. 173, 1644 (1968)

**Elastic Unitarity and Phase Equality of Scattering Amplitudes**—A. Giovannini, E. Predazzi, and F. Selleri. 173, 1660 (1968)

**S-Matrix Approach to Internal Symmetries. II**—S. M. Roy. 173, 1671 (1968)

**Kinematic Singularities and Constraints of Helicity Amplitudes**—T. L. Trueman. 173, 1684 (1968)

**Watson's Theorem When There Are Three Strongly Interacting Particles in the Final State**—I. J. R. Aitchison and C. Kacser. 173, 1700 (1968)

**Harmonic-Oscillator Model for Baryons**—David Faiman and Archibald W. Hendry. 173, 1720 (1968)

**Asymptotic Sum Rules**—Myron Bander and J. D. Bjorken. 174, 1704 (1968)

**Correlation between Transcendental and Polynomial Lagrangians**—H. M. Fried. 174, 1725 (1968)

**Scalar Fields Coupled to the Trace of the Energy-Momentum Tensor**—Peter G. O. Freund and Yoichiro Nambu. 174, 1741 (1968)

**Causality in S-Matrix Theory**—Colston Chandler. 174, 1749 (1968)

**Calculation of Elastic Scattering Amplitude by Conformal Mapping**—György Steinbrecher. 174, 1794 (1968)

**Chiral Symmetry from Divergence Requirements**—D. B. Fairlie and K. Yoshida. 174, 1816 (1968)

**Pion Form-Factor Zero and "Dipole" Nucleon Structure**—J. J. Brehm and L. F. Cook. 174, 1901 (1968)

**Dispersion Methods in the 2V Sector of the Lee Model**—Leonard M. Scarfone. 174, 1903 (1968)

**O(4) Symmetry and the Regge Trajectory of the Pion**—W. R. Frazer, H. M. Lipinski, and D. R. Snider. 174, 1932 (1968)

**Hard-Pion Current-Algebra Calculation of Meson Processes—Three-Point Functions**—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 1999 (1968)

**Application of Hard-Pion Three-Point Functions**—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 2008 (1968)

**Analytic Continuation of an Amplitude**—W. J. Abbe and G. A. Gary. 174, 2015 (1968)

**Relativistic Three-Body Theory with Applications to $\pi$-$N$ Scattering**—R. Aaron, R. D. Amado, and J. E. Young. 174, 2022 (1968)

**Modified Phase Representation and Effects of Inelasticity in $N/D$ Calculation of $p$-Wave Pion-Pion Scattering**—Barbara Hale and Arnold Tubis. 174, 2074 (1968)

**Recoil and Rescattering Effects in the Strong Decays of Higher Mesons in the Quark Model**—D. K. Choudhury. 174, 2101 (1968)

**Radiative Correction to Pion Photoproduction**—Charles Picciotto and Allan S. Krass. 174, 2109 (1968)

**Splitting, Mixing, and Small Perturbations in $SU(3)$ Multiplets of Vector Mesons**—L. F. Cook and H. L. Watson. 174, 2113 (1968)

**Erratum: Existence Proof by a Fixed-Point Theorem for Solutions of the Low Equation**—Robert L. Warnock. [170, 1323 (1968)] 174, 2169 (1968)

**Derivation of the Mass and Spin Spectrum for Mesons and Baryons**—A. Böhm. 175, 1767 (1968)

**Analyticity and Broken $SL(2, C)$ Symmetry for Regge Families**—P. K. Kuo and James F. Walker. 175, 1794 (1968)

**Hard-Pion Current-Algebra Calculation of Meson Processes—$N$-Point Functions**—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1802 (1968)

**Application of Hard-Pion Four-Point Functions to Pion-Pion Scattering**—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1820 (1968)

**Method of Pole Dominance and Applications**—John H. Schwarz. 175, 1852 (1968)

**Vertex-Strength-Algebra Treatment of Vector-Meson Photoproduction**—A. C. Hirshfeld and L. P. Horwitz. 175, 1865 (1968)

**Structure of Three-Point Functions from $SU(3)\otimes SU(3)$ Algebra**—Ira S. Gerstein, Howard J. Schnitzer, and Steven Weinberg. 175, 1873 (1968)

**Chiral $SU(3)\otimes SU(3)$ Three-Point Function: Single-Particle Approximation**—Ira S. Gerstein and Howard J. Schnitzer. 175, 1876 (1968)

**Factorization and Constraints in Regge-Pole Theory**—A. Capella, A. P. Contogouris, and J. Tran Thanh Van. 175, 1892 (1968)

**Corrections to the Coleman-Glashow Sum Rule**—Stephen Brook Fels. 175, 1895 (1968)

**Prediction for the Reaction $\pi N \to \pi N^*$ Based on a Partially Conserved Axial-Vector Current**—M. E. Arons. 175, 1905 (1968)

**Dipole $\rho$ Meson, Nucleon Form Factors, and Charge-Exchange Scattering**—R. E. Kreps and J. W. Moffat. 175, 1942 (1968)

**Nucleon and Pion Form Factors and the Dipole $\rho$ Meson**—R. E. Kreps and J. W. Moffat. 175, 1945 (1968)

**Eigenvectors for the Partial-Wave "Crossing Matrices"**—A. P. Balachandran, W. J. Meggs, and P. Ramond. 175, 1974 (1968)

**Pion Photoproduction, $NN$ Scattering, and Photoproduction Sum Rules**—Richard C. Brower and Jan W. Dash. 175, 2014 (1968)

**Theory of Pion-Pion Scattering**—Naohiko Masuda. 175, 2087 (1968)

**Crossing-Symmetric Rising Regge Trajectories**—Shu-Yuan Chu, Gary Epstein, Peter E. Kaus, Richard C. Slansky, and Fredrik Zachariasen. 175, 2098 (1968)

**Two-Temperature Statistical Model of Particle Spectra**—J. R. Wayland. 175, 2106 (1968)

**Analyticity and the Daughter Structure of Conspiring Regge-Pole Families**—Lorella Jones and Harvey K. Shepard. 175, 2117 (1968)

**Current-Current Interaction and Calculation of the Nonleptonic Baryon Decays**—Shmuel Nussinov and Giuliano Preparata. 175, 2180 (1968)

**Quasidiffraction Scattering and Selection Rules for Spin and Parity**—L. Resnick. 175, 2185 (1968)

**Behavior of Current Divergences under $SU_3 \times SU_3$**—Murray Gell-Mann, R. J. Oakes, and B. Renner. 175, 2195 (1968)

**Analyticity and Broken $O(4)$ Symmetry**—J. B. Bronzan, C. Edward Jones, and P. K. Kuo. 175, 2200 (1968)

Physical Region on the Plane of Two Invariant Momentum Transfers for a Reaction with Three Particles in the Final State—K. Kajantie and P. Lindblom. 175, 2203 (1968)

Simultaneous Partial-Wave Expansion in the Mandelstam Variables: The Group $SU(3)$—A. P. Balachandran, W. J. Meggs, J. Nuyts, and P. Ramond. 176, 1700 (1968)

Equivalent-Potential Approach Using the Bethe-Salpeter and Unitarity Equations—Louis A. P. Balázs. 176, 1769 (1968)

Factorization, Kinematic Singularities, and Conspiracies—Farzam Arbab and J. D. Jackson. 176, 1796 (1968)

Divergent Part of the Second-Order Electromagnetic Corrections to the Ratio $G_A/G_V$—A. Sirlin. 176, 1871 (1968)

Effect of the Existence of an Elementary Quark on High-Energy Scattering—Stuart D. Anderson. 176, 1881 (1968)

Bootstrap of Meson Trajectories from Superconvergence—M. Ademollo, H. R. Rubinstein, G. Veneziano, and M. A. Virasoro. 176, 1904 (1968)

Unitarity-Analyticity Equations for Elastic Pion-Nucleon Scattering: A Numerical Solution—John R. Boccio. 176, 1934 (1968)

Argand-Diagram Loops and Regge Poles—P. D. B. Collins, R. C. Johnson, and G. G. Ross. 176, 1952 (1968)

Multi-Reggeon Behavior of Production Amplitudes—I. T. Drummond. 176, 2003 (1968)

Currents as Dynamical Variables—Charles M. Sommerfield. 176, 2019 (1968)

Cancellation of Divergences in Reggeized Electromagnetic Mass Differences—Arnulf Rabl. 176, 2034 (1968)

Model of High-Energy Meson Photoproduction—T. T. Chou. 176, 2041 (1968)

Connection between the Toller Quantum Number $M$ and the Small-$t$ Behavior of the Asymptotic $S$-Channel Helicity Amplitudes—John F. Gunion and H. M. Lipinski. 176, 2045 (1968)

Meson-Baryon and Baryon-Baryon Scattering in Reggeized $U(6)\otimes U(6)$ Theory—R. Delbourgo and Harun-ar Rashid. 176, 2074 (1968)

Lorentz Poles and Bethe-Salpeter Equations: Does an Infinite Number of Lorentz Poles Exist?—N. P. Chang and R. P. Saxena. 176, 2101 (1968)

Multiperipheral Bootstrap Model—G. F. Chew and A. Pignotti. 176, 2112 (1968)

Proposed Test of Toller $\omega$ Dependence of Two-Reggeon–One-Particle Vertex Functions—Richard A. Morrow. 176, 2147 (1968)

Relation between the Damping of Large Transverse Momenta in Elastic and Inelastic Collisions from Unitarity—D. S. Narayan. 176, 2154 (1968)

Deck-Model Calculation for Doubly Charged $K\pi\pi$ Systems in $KN \to K^*\pi N$ Reactions—F. Bomse and E. J. Moses. 176, 2163 (1968)

Erratum: Solutions of the Bethe-Salpeter and $N/D$ Equations—K. V. Vasavada. [165, 1830 (1968)] 176, 2167 (1968)

## 64.7 Strong (Baryon No. = 0)

Theoretical Study of $K_{l_4}$ Decay—F. A. Berends, A. Donnachie and G. C. Oades. 171, 1457 (1968)

Vector and Axial-Vector Meson Dominance in the $K_{3\pi}$ Decays—R. H. Graham and S. K. Yun. 171, 1550 (1968)

Induction of Symmetries for a Set of Mesons of Both Parities—Richard H. Capps. 171, 1591 (1968)

Two Simple Approximation Schemes for Lippmann-Schwinger-Type Equations—L. A. P. Balázs and Sharashchandra H. Patil. 171, 1633 (1968)

Sum Rules from Charge-Charge-Density and Charge-Charge Commutators—S. Matsuda and S. Oneda. 171, 1743 (1968)

Diffractive $2\pi$ Production and $\pi$-$\pi$ Interactions—S. Nussinov. 172, 1446 (1968)

$O(4)$, Off-Shell $N\bar{N}$ Scattering, and Massless Pions—A. H. Mueller. 172, 1516 (1968)

Scalar- and Tensor-Tadpole Contribution to $K^0$-$K^+$ Mass Difference—Sharashchandra H. Patil. 172, 1528 (1968)

Spectral-Function Sum Rules with Symmetry Breaking—Tomoya Akiba and Kyungsik Kang. 172, 1551 (1968)

Spectral Representations for Symmetry-Breaking Parameters—Robert Perrin. 172, 1675 (1968)

Phase-Space Distributions for the $4\pi$ Decay Mode of Isosinglet Bosons—T. J. Nelson. 172, 1701 (1968)

Spectral-Function Sum Rules and the Ratio $f_K/f_\pi$—Riazuddin and Fayyazuddin. 172, 1737 (1968)

Modified Dispersion Relations and $\pi\pi$ Scattering—David J. George, Barbara Hale, and Arnold Tubis. 172, 1740 (1968)

Accurate Solution of a Bethe-Salpeter Equation for a Fermion-Antifermion System Bound via Vector Exchange—P. Narayanaswamy and Antonio Pagnamenta. 172, 1750 (1968)

$(K\pi)$ Phase Shifts from a Current-Algebra Model—Antonio Pagnamenta and B. Renner. 172, 1761 (1968)

Erratum: $K\pi$ Scattering, $\kappa$ Meson, and Current Algebra—Probir Roy. [168, 1708 (1968)] 172, 1850 (1968)

Pomeranchuk Theorem for Partial Waves and Narrowing of Resonance Widths: The $\rho$ Meson—Bipin R. Desai and David T. Gregorich. 173, 1434 (1968)

Current Algebra, Crossing Symmetry, and Unitarity for $s$-Wave $\pi\pi$ Scattering—K. Datta, K. C. Gupta, and V. S. Varma. 173, 1549 (1968)

Broken-Symmetry Model of Meson Interactions—L. A. Copley, D. K. Elias, and D. Masson. 173, 1552 (1968)

$T=0$, $J=0$ Pion-Pion Interaction—G. W. Ellison and S. Humble. 173, 1563 (1968)

Double Bootstrap of the $\rho$ and $f^0$—Allen E. Everett. 173, 1663 (1968)

Rate of $A_1 \to \rho\pi$ from Asymptotic Chiral Symmetry—A. Zee. 173, 1788 (1968)

Erratum: Reggeization of External Particles—M. L. Thiebaux. [170, 1244 (1968)] 173, 1806 (1968)

Asymptotic Sum Rules for Three-Point Functions: the $A_1$-$\rho$-$\pi$ System—V. S. Mathur. 174, 1743 (1968)

Bjorken Limit and Pole Dominance. I. The $\omega\rho\pi$ System and the Algebra of Fields—Stanley G. Brown and Geoffrey B. West. 174, 1777 (1968)

Bjorken Limit and Pole Dominance. II. Virtual $\pi\rho$ Scattering—Stanley G. Brown and Geoffrey B. West. 174, 1786 (1968)

Self-Consistent Calculation of Vector- and Pseudoscalar-Meson Mass Splittings—S. L. Cohen. 174, 1867 (1968)

Dynamics at High Spin of the $\rho$-$A_2$ Trajectory—Hyman Goldberg. 174, 1913 (1968)

Derivation of Intermultiplet Mass Formulas from the Chiral $SU(3)\otimes SU(3)$ Charge Algebra—S. Matsuda and S. Oneda. 174, 1992 (1968)

Hard-Pion Current-Algebra Calculation of Meson Processes—Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 1999 (1968)

Application of Hard-Pion Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 2008 (1968)

Once-Subtracted Dispersion Relations, Current Algebra, and $K_{l_3}$ Form Factors—J. C. Pati and K. J. Sebastian. 174, 2033 (1968)

Modified Phase Representation and Effects of Inelasticity in $N/D$ Calculation of $p$-Wave Pion-Pion Scattering—Barbara Hale and Arnold Tubis. 174, 2074 (1968)

Hard-Kaon Processes and the Spectral-Function Sum Rules—Yoshiaki Ueda. 174, 2082 (1968)

Recoil and Rescattering Effects in the Strong Decays of Higher Mesons in the Quark Model—D. K. Choudhury. 174, 2101 (1968)

Sum Rules Involving the $\rho$ and $A_1$ Mesons and the $A_1 \to \rho + \pi$ Decay—S. Matsuda and S. Oneda. 174, 2106 (1968)

Spin-Parity Analysis of the Low-Mass (1.1–1.4 BeV) $K^+\pi$ System in $K^-p \to \overline{K}^{*0}\pi^-p$ at 5.5 BeV/$c$—J. C. Park and S. Kim. 174, 2165 (1968)

Hard-Pion Current-Algebra Calculation of Meson Processes —$N$-Point Functions—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1802 (1968)

Application of Hard-Pion Four-Point Functions to Pion-Pion Scattering—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1820 (1968)

Method of Pole Dominance and Applications—John H. Schwarz. 175, 1852 (1968)

Theory of Pion-Pion Scattering—Naohiko Masuda. 175, 2087 (1968)

Threshold Behavior of Partial-Wave Dispersion Relation and Short-Range Force—Naohiko Masuda. 175, 2093 (1968)

Crossing-Symmetric Rising Regge Trajectories—Shu-Yuan Chu, Gary Epstein, Peter E. Kaus, Richard C. Slansky, and Fredrik Zachariasen. 175, 2098 (1968)

Compilation of $\pi^-p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

Scalar Density Terms, $K\pi$ and $KK$ Scattering Lengths, and a Symmetry-Breaking Parameter—Richard W. Griffith. 176, 1705 (1968)

Interference, Mixing, and Angular Correlations in Decays of Boson Resonances—Harry J. Lipkin. 176, 1709 (1968)

Possible Classification of Exchange-Degenerate Trajectories—Akbar Ahmadzadeh and Richard J. Jacob. 176, 1719 (1968)

Equivalent-Potential Approach Using the Bethe-Salpeter and Unitarity Equations—Louis A. P. Balázs. 176, 1769 (1968)

Bootstrap of Meson Trajectories from Superconvergence—M. Ademollo, H. R. Rubinstein, G. Veneziano, and M. A. Virasoro. 176, 1904 (1968)

Meson Bootstraps for Unnatural-Parity States—M. Bishari, H. R. Rubinstein, A. Schwimmer, and G. Veneziano. 176, 1926 (1968)

$O(4)$ Symmetry, $N\bar{N}$ Scattering, and the Regge Trajectory of the Pion—H. M. Lipinski and D. R. Snider. 176, 2054 (1968)

Universal Coupling of the $\omega$ Meson and Regge Residues—M. K. Banerjee and C. A. Levinson. 176, 2140 (1968)

Deck-Model Calculation for Doubly Charged $K\pi\pi$ Systems in $KN \to K^*\pi N$ Reactions—F. Bomse and E. J. Moses. 176, 2163 (1968)

## 64.8 Strong (Baryon No. = 1)

$K_1^0 + p \to K_1^0 + p$ and the Regge Trajectory of the $\omega$ Meson—Frederick J. Gilman. 171, 1453 (1968)

Backward ($\theta$=180°) $\pi N$ Dispersion Relations: Applications to the Interference Model, $P$ and $P'$ Trajectories, and to the Mechanical Form Factors of the Nucleon—Hyman Goldberg 171, 1485 (1968)

Kinematical Singularities and Zeros for the Reaction $\gamma N \to VN$—E. Gotsman and U. Maor. 171, 1495 (1968)

Threshold and Pseudothreshold Relations for Meson-Baryon Scattering—Frank S. Henyey. 171, 1509 (1968)

Interference of Kaon Resonances—G. L. Kane and H. S. Mani. 171, 1533 (1968)

Pion-Nucleon Spin-Flip Current-Algebra Sum Rule—Eugen E. Radescu. 171, 1655 (1968)

Inelastic Contribution to the $p$-$n$ Mass Difference in Cottingham's Formula—Taizo Muta. 171, 1661 (1968)

Superconvergence and Regge Poles. I. Odd-Signature Exchanges—M. G. Olsson. 171, 1681 (1968)

Pion-Nucleon Scattering and $SO(4)$ Symmetry—N. W. Macfadyen. 171, 1691 (1968)

Process $\pi^-p \to \pi^+\pi^-n$ near Threshold—S. Humble and T. D. Spearman. 171, 1724 (1968)

Pion Conspiracy and Pion Residue from the Finite-Energy Photoproduction Sum Rule—D. P. Roy and Shu-Yuan Chu. 171, 1762 (1968)

Pion Production, Current Algebra, and Coupling-Constant Relations—A. N. Mitra and R. Nath. 171, 1798 (1968)

Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: General Features—P. Babu, S. Frautschi, and N. S. Thornber. 172, 1389 (1968)

Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: Detailed Calculation—N. S. Thornber. 172, 1395 (1968)

Off-Mass-Shell Approach to Strong Decays of Baryon Resonances—Masao Sugawara. 172, 1423 (1968)

Consequences of a $QQ\bar{Q}$ Model for Meson-Baryon Processes —S. Das Gupta, V. K. Gupta, and A. N. Mitra. 172, 1482 (1968)

Superconvergent Dispersion Relation and Low-Energy Kaon-Proton Interaction—Yu-Chien Liu. 172, 1564 (1968)

Regge-Pole Analysis of Charge-Exchange and Hypercharge-Exchange Reactions in Pseudoscalar-Meson–Baryon Scattering—D. D. Reeder and K. V. L. Sarma. 172, 1566 (1968)

Sum-Rule Constraints on Baryon Regge Trajectories—P. B. James. 172, 1602 (1968)

Reaction Amplitudes for Pseudoscalar Mesons on Spin-$\frac{1}{2}$ Fermions in Fourth-Order Perturbation Theory—Joseph J. Kubis and John L. Gammel. 172, 1664 (1968)

$SU(3)$-Symmetry Breaking in a Bethe-Salpeter Bootstrap Model—E. Golowich. 172, 1834 (1968)

Erratum: Generalized Pole-Dominance Hypothesis, Current Algebra, and $S$-Wave $K^+p$ Scattering—Probir Roy. [162, 1644 (1967)] 172, 1849 (1968)

Inelastic Electron Scattering in the Symmetric Quark Model. II. Coulomb Potential—N. S. Thornber. 173, 1414 (1968)

$T$=0, $J$=0 Pion-Pion Interaction—G. W. Ellison and S. Humble. 173, 1563 (1968)

Polarization in $\pi^-p \to \eta n$, the Double-Pole $A_2$, and a Possible Pion Conspirator—D. M. Austin, J. V. Beaupre, and K. E. Lassila. 173, 1573 (1968)

Rescattering Model Applied to $Y^*$ Production—C. P. Singh and B. K. Agarwal. 173, 1611 (1968)

Anomalous Nuclear Photoproduction of $\phi$ Mesons—J. S. Trefil. 173, 1629 (1968)

Threshold Electropion Production from Current Algebra and Partially Conserved Axial-Vector Current—A. M. Gleeson, M. G. Gundzik, and Jacob G. Kuriyan. 173, 1708 (1968)

Harmonic-Oscillator Model for Baryons—David Faiman and Archibald W. Hendry. 173, 1720 (1968)

Sum Rules for Meson-Baryon Scattering from Asymptotic Symmetry Requirements—V. P. Seth, B. K. Agarwal, and Y. M. Gupta. 173, 1759 (1968)

Baryon Resonances and Regge Trajectories—Richard M. Spector. 173, 1761 (1968)

Study of $\pi N$ and $KN$ Elastic and Inelastic Scatterings and their Polarizations by a Multiple-Regge-Pole Model—Fei S. Chen-Cheung and Timothy Roth. 173, 1768 (1968)

**Parameters of Low-Energy $\Lambda$-$K^0$ Production**—J. Edwin Rush, Jr. 173, 1776 (1968)
Calculation of the $P_{11}$ $\pi N$ Phase Shift Using Coupled $\pi N$, $\sigma N$, and $\epsilon N$ Channels—Ernestos N. Argyres and Aaron Rotstein. 174, 1689 (1968)
Off-Mass-Shell Approach to Nucleon Resonances of Spin $\frac{3}{2}$ and Isospin $\frac{1}{2}$—Masao Sugawara and James W. Meyer. 174, 1709 (1968)
Off-Mass-Shell Corrections to Current-Algebra Calculation of $\pi N$ $S$-Wave Scattering Lengths—David N. Levin. 174, 1759 (1968)
Chiral Dynamics for High-Spin Baryons and an Application to Double-Pion Photoproduction—H. W. Huang. 174, 1799 (1968)
Application of Modified Dispersion Relations to the Forward $KN$ Crossing-Even Scattering Amplitude—David J. George and Arnold Tubis. 174, 1871 (1968)
Regge Parameters in Crossing-Even $KN$ Scattering—David J. George and Arnold Tubis. 174, 1875 (1968)
Current Algebra and Double-Pion Photoproduction—S. C. Bhargava. 174, 1969 (1968)
Inelastic Effects in $P_{11}$-State $\pi N$ Scattering—Kwok Maw Ong. 174, 1977 (1968)
Relativistic Three-Body Theory with Applications to $\pi$-$N$ Scattering—R. Aaron, R. D. Amado, and J. E. Young. 174, 2022 (1968)
Single-Parameter Fit to Meson-Nucleon Forward Reactions—Jane C. Jackson. 174, 2098 (1968)
Isospin and $U$-Spin Dependence of Hadron-Nucleon Total Cross Sections—Harry J. Lipkin. 174, 2151 (1968)
High-Energy Polarized-Photon Reactions—Robert L. Thews. 175, 1749 (1968)
Lorentz-Pole Model and Polarization in High-Energy Charge-Exchange Pion-Nucleon Scattering—N. G. Antoniou, S. R. Komy, C. D. Palev, and M. Samiullah. 175, 1757 (1968)
Regge Poles and Finite-Energy Sum Rules for Kaon-Nucleon Scattering—Guru Vachan Dass and C. Michael. 175, 1774 (1968)
Method of Pole Dominance and Applications—John H. Schwarz. 175, 1852 (1968)
Pion-Nucleon Elastic Scattering above 1 GeV—E. Rost and L. Marshall Libby. 175, 1869 (1968)
Prediction for the Reaction $\pi N \to \pi N^*$ Based on a Partially Conserved Axial-Vector Current—M. E. Arons. 175, 1905 (1968)
Puzzle of Regge Dips—Ralph Roskies. 175, 1933 (1968)
Dipole $\rho$ Meson, Nucleon Form Factors, and Charge-Exchange Scattering—R. E. Kreps and J. W. Moffat. 175, 1942 (1968)
Pion Photoproduction and Fixed-$t$ Dispersion Relations—J. Engels, A. Müllensiefen, and W. Schmidt. 175, 1951 (1968)
Regge-Pole Model with the $M = 1$ Pion in $\pi^+p \to \rho^0\Delta^{++}$ and $\pi^+p \to \rho^+p$ Scattering—Farzam Arbab and Richard C. Brower. 175, 1991 (1968)
Reanalysis of the Lowest-Mass Negative-Parity Baryon Resonances Using the Symmetric Quark Model—D. R. Divgi and O. W. Greenberg. 175, 2024 (1968)
Decays of Negative-Parity Baryons in a Quark Model—D. R. Divgi. 175, 2027 (1968)
$s$-Wave $K^+p$ Dynamics—B. R. Martin. 175, 2034 (1968)
Current Algebra and $K^+\Lambda$ Photoproduction—Debabrata Basu and R. N. Chaudhuri. 175, 2075 (1968)
Quark Interactions and Nucleon Form Factors—G. M. Cicuta, G. Marchesini, and A. Scotti. 175, 2113 (1968)
Continuous-Moment Sum Rules and Pion Conspiracy in Photoproduction—K. Raman and Kashyap V. Vasavada. 175, 2191 (1968)
Erratum: Sum Rules for the Axial-Vector Coupling Constant Renormalization in $\beta$ Decay—Stephen L. Adler. [140, B736 (1965); 149, 1294(E) (1966)], 175, 2224 (1968)
Compilation of $\pi^-p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)
Can the Parity of the $\Omega^-$ Be Measured?—G. L. Kane and Michael J. Moravcsik. 176, 1733 (1968)
Representation Mixing and $SU_3$ Symmetry Breaking in the $\frac{1}{2}^-$ Baryon Octet—Peter N. Dobson, Jr. 176, 1757 (1968)
Decays of Odd-Parity Baryon Resonances—J. C. Carter and M. E. M. Head. 176, 1808 (1968)
Chiral Lagrangian Calculation of Pion-Nucleon Scattering Lengths—R. D. Peccei. 176, 1812 (1968)
Complex $\bar{K}N$ Scattering Lengths and Current Algebra—Debabrata Basu, S. N. Biswas, and K. Datta. 176, 1835 (1968)
Rescattering Effects in the Quark Model for Meson-Baryon Couplings—J. D. Anand, V. S. Bhasin, and A. N. Mitra. 176, 1891 (1968)
Unitarity-Analyticity Equations for Elastic Pion-Nucleon Scattering: A Numerical Solution—John R. Boccio. 176, 1934 (1968)
Argand-Diagram Loops and Regge Poles—P. D. B. Collins, R. C. Johnson, and G. G. Ross. 176, 1952 (1968)
$K^*(890)$ Photoproduction in the Regge-Pole Model—N. S. Thornber. 176, 1998 (1968)
Regge-Pole Eikonal Theory of Small-Angle Pion-Nucleon Scattering—Richard C. Arnold and Maurice L. Blackmon. 176, 2082 (1968)
Universal Coupling of the $\omega$ Meson and Regge Residues—M. K. Banerjee and C. A. Levinson. 176, 2140 (1968)
Superconvergence Relations and Possible New Resonances in Pion-Baryon Scattering—D. Kiang, W. C. Lin, R. Sugano, H. E. Lin, and Y. Nogami. 176, 2159 (1968)
Deck-Model Calculation for Doubly Charged $K\pi\pi$ Systems in $KN \to K^*\pi N$ Reactions—F. Bomse and E. J. Moses. 176, 2163 (1968)
Critique of Empirical Mass Formula for Baryons—Mohammad Saleem. 176, 2166 (1968)

## 64.9 Strong (Baryon No.>2) (see also 51.6)

Off-Energy-Shell $t$-Matrix Elements for Local Potentials Containing Hard Cores—Robert Laughlin and Bruce L. Scott. 171, 1196 (1968)
Analysis of the $\Lambda\Lambda$ Hypernucleus ${}_{\Lambda\Lambda}C^{14}$—S. Ali, L. P. Kok, and M. E. Grypeos. 171, 1203 (1968)
Velocity-Dependent Potential Parametrization for ${}^1S_0$ Elastic Proton-Proton Scattering—John E. Brolley. 171, 1439 (1968)
High-Energy Hadron-Nucleus Collisions. I. Protons—Alfred S. Goldhaber and Charles J. Joachain. 171, 1566 (1968)
Two-Body $K^-d$ Reactions as a Test of One-Meson Exchange—M. E. Schillaci and R. R. Silbar. 171, 1764 (1968)
Approximate Bounds on Coupling Constants from Analyticity, Crossing, and Unitarity—D. Atkinson and F. Calogero. 171, 1767 (1968)
Optical-Model Analysis of Pion-Nucleus Scattering. II. Pion Form Factor—E. H. Auerbach, D. M. Fleming, and M. M. Sternheim. 171, 1781 (1968)
Diffraction-Disassociation Model of Very-High-Energy Nucleon-Nucleon Interactions and the Diffusion of Cosmic Rays through the Atmosphere—Robert K. Adair. 172, 1370 (1968)

Paraquarks, Structural Saturation, and Hard Core—A. N. Mitra and S. A. Moszkowski. 172, 1474 (1968)
High-Energy Proton-Proton Scattering and Nucleon Structure: The Scalar Interaction in $O(4,2)$—A. O. Barut and Dennis Corrigan. 172, 1593 (1968)
Zero-Parameter Model of the $N$-$N$ Potential—Hirotaka Sugawara and Frank von Hippel. 172, 1764 (1968)
Two-Pion-Exchange Theory. Nucleon-Nucleon Scattering—P. C. M. Yock. 172, 1844 (1968)
Extracting the Phase of Scattering Amplitudes by Means of the Glauber Formula—J. C. Vander Velde. 173, 1544 (1968)
Elastic Scattering from Deuterium—Jon Pumplin. 173, 1651 (1968)
Nuclear Forces—Lester Ingber. 174, 1250 (1968)
Realistic $N$-$N$ One-Boson-Exchange Potentials—T. Ueda and A. E. S. Green. 174, 1304 (1968)
Large-Angle Proton-Proton Scattering and the Pomeranchuk Trajectory—Kerson Huang and Stephen Pinsky. 174, 1915 (1968)
Regge-Pole Formalism for Pionic Disintegration of Deuteron—Huan Lee. 174, 2130 (1968)
$\Lambda$-$\Sigma$ Conversion and $\Lambda np$ Isospin-Zero Bound States—Alan J. Toepfer and L. H. Schick. 175, 1253 (1968)
Separable-Potential Fits to Nucleon-Nucleon Scattering Data—Thomas R. Mongan. 175, 1260 (1968)
High-Energy Nucleus-Nucleus Collisions. I. General Theory and Applications to Deuteron-Deuteron Scattering—Victor Franco. 175, 1376 (1968)
Resonance Production in Proton-Proton Scattering at 12.5 and 30 BeV/$c$—E. Yen. 175, 1982 (1968)
Further Comments on the Description of Three-Body Associated Production in Proton-Proton Collisions through the One-Boson-Exchange Model—E. Ferrari. 175, 2003 (1968)
Pion Production in the Proton-Deuteron Interaction—P. K. Patnaik. 175, 2069 (1968)
Low-Energy Properties of Realistic $N$-$N$ One-Boson-Exchange Potentials—Alexander Gersten and A. E. S. Green. 176, 1199 (1968)
High-Energy Scattering at Moderately Large Angles—L. I. Schiff. 176, 1390 (1968)
Nucleon-Nucleon Models, Charge Splitting, and the Nucleon-Nucleon Data near 210 MeV—M. D. Miller, P. S. Signell, and N. R. Yoder. 176, 1724 (1968)
Two-Pion-Exchange Contributions to Nucleon-Nucleon Scattering—W. R. Wortman. 176, 1762 (1968)
Three-Body Interaction Effects in High-Energy Scattering from Deuterons—David R. Harrington. 176, 1982 (1968)
Two-Boson-Exchange Effects in Nucleon-Nucleon Scattering—Richard D. Haracz and Ravi D. Sharma. 176, 2013 (1968)
High-Energy Scattering by Nuclei—Edward A. Remler. 176 2108 (1968)
Multiperipheral Bootstrap Model—G. F. Chew and A. Pignotti. 176, 2112 (1968)
Proposed Test of Toller $\omega$ Dependence of Two-Reggeon–One-Particle Vertex Functions—Richard A. Morrow. 176, 2147 (1968)

## 65 SCATTERING THEORY (see also 51.6)

Parametrization of Absorption-Line Profiles—Bruce W. Shore. 171, 43 (1968)
Resonance Widths and Spacings: Their Averages and Distributions—P. A. Moldauer. 171, 1164 (1968)
Off-Energy-Shell $t$-Matrix Elements for Local Potentials Containing Hard Cores—Robert Laughlin and Bruce L. Scott. 171, 1196 (1968)
Time Delay of Scattering Processes—Jorge L. Agudín. 171 1385 (1968)
Construction of Local Quantum Fields Describing Many Masses and Spins—Henry D. I. Abarbanel and Y. Frishman. 171, 1442 (1968)
Singularities of a Bethe-Salpeter Amplitude—H. S. Green and S. N. Biswas. 171, 1511 (1968)
Complex Angular Momentum and Infinite Helicity Sums. II—G. A. Winbow. 171, 1517 (1968)
Calculation of Some Three-Body Scattering Amplitudes—L. Schlessinger. 171, 1523 (1968)
Centrifugal-Barrier Effects in $N/D$ Calculations—R. W. Childers and A. W. Martin. 171, 1540 (1968)
Variational Principles for Crossing-Symmetric Off-Shell Equations—Richard W. Haymaker and R. Blankenbecler. 171, 1581 (1968)
Extension of the Contour-Distortion Method in Relativistic Three-Particle Scattering—G. D. McCartor and J. Nuttall. 171, 1627 (1968)
Approximate Bounds on Coupling Constants from Analyticity, Crossing, and Unitarity—D. Atkinson and F. Calogero. 171, 1767 (1968)
Natural Zeros of Regge Residues—H. F. Jones and M. D. Scadron. 171, 1809 (1968)
Coulomb Interference in High-Energy Scattering—Geoffrey B. West and D. R. Yennie. 172, 1413 (1968)
Third Sector of the Lee Model—J. B. Bronzan. 172, 1429 (1968)
Parity Doubling for Bosons and $M^2=1$ Propagators—V. A. Alessandrini. 172, 1503 (1968)
Majorana Equations for Composite Systems—G. Bisiacchi, P. Budini, and G. Calucci. 172, 1508 (1968)
Regge-Pole Analysis of Charge-Exchange and Hypercharge-Exchange Reactions in Pseudoscalar-Meson–Baryon Scattering—D. D. Reeder and K. V. L. Sarma. 172, 1566 (1968)
Phase Contours of Scattering Amplitudes. III. High Energy Behavior at Fixed Angles—Richard J. Eden and Chung-I Tan. 172, 1583 (1968)
Tree Graphs and Classical Fields—David G. Boulware and Lowell S. Brown. 172, 1628 (1968)
Conspirators and Daughters in Unequal-Mass, Nonzero-Spin Scattering—Matthew A. Jacobs and Mark H. Vaughn. 172, 1677 (1968)
Accurate Solution of a Bethe-Salpeter Equation for a Fermion-Antifermion System Bound via Vector Exchange—P. Narayanaswamy and Antonio Pagnamenta. 172, 1750 (1968)
Large-Angle Scattering and the Fifth Interaction—Y. Ne'eman. 172, 1818 (1968)
Simultaneous "Partial-Wave" Expansion in the Mandelstam Variables: Crossing Symmetry for Partial Waves—A. P. Balachandran and J. Nuyts. 172, 1821 (1968)
Erratum: Perturbed Bound-State Poles in Potential Scattering. II—Y. S. Kim and Kashyap V. Vasavada. [150, 1236 (1966)] 172, 1849 (1968)
Faddeev Equations for Atomic Problems and Solutions for the ($e$, H) System—James S. Ball, Joseph C. Y. Chen, and David Y. Wong. 173, 202 (1968)
Upper and Lower Bounds on $s$-Wave Electron-Hydrogen Scattering. I—Rabinder N. Madan. 173, 214 (1968)
Pomeranchuk Theorem for Partial Waves and Narrowing of Resonance Widths: The $\rho$ Meson—Bipin R. Desai and David T. Gregorich. 173, 1434 (1968)
Unitarity and the Mandelstam Representation. II. Large-Angular-Momentum Partial-Wave Amplitudes—Arthur W. Martin. 173, 1439 (1968)
Extracting the Phase of Scattering Amplitudes by Means of the Glauber Formula—J. C. Vander Velde. 173, 1544 (1968)

Analytic Properties of Current-Algebra Vertex Functions—Myron Bander. 173, 1568 (1968)
Multiple Scattering in the Quark Model—David R. Harrington and Antonio Pagnamenta. 173, 1599 (1968)
$O(4)$ Symmetry in Feynman Amplitudes—Yoichi Iwasaki. 173, 1608 (1968)
Generalized Superperturbation Theory for Scattering—Rabinder N. Madan. 173, 1615 (1968)
Elastic Unitarity and Phase Equality of Scattering Amplitudes—A. Giovannini, E. Predazzi, and F. Selleri. 173, 1660 (1968)
Double Bootstrap of the $\rho$ and $f^0$—Allen E. Everett. 173, 1663 (1968)
High-Energy Multiple Scattering for Large Angles—D. K. Ross. 173, 1695 (1968)
Relativistic Particle-Antiparticle Stationary States in a Model Quantum Field Theory: Mesons from Quarks—Gerald Rosen. 173, 1680 (1968)
Kinematic Singularities and Constraints of Helicity Amplitudes—T. L. Trueman. 173, 1684 (1968)
Watson's Theorem When There Are Three Strongly Interacting Particles in the Final State—I. J. R. Aitchison and C. Kacser. 173, 1700 (1968)
Covariant $M$ Functions for Higher Spin—M. D. Scadron and H. F. Jones. 173, 1734 (1968)
Three-Particle Final States in the Quark Model—Sutapa Das Gupta. 173, 1745 (1968)
Baryon Resonances and Regge Trajectories—Richard M. Spector. 173, 1761 (1968)
Scattering Model with Crossing Symmetry and Minimal Inelastic Effects—Franklin F. K. Cheung and John S. Toll. 173, 1791 (1968)
Erratum: Reggeization of External Particles—M. L. Thiebaux. [170, 1244 (1968)] 173, 1806 (1968)
Separable $t$ Matrices and Hard-Core Potentials—Michael G. Fuda. 174, 1134 (1968)
Low-Energy Method in High-Energy Scatterings—Yukap Hahn. 174, 1135 (1968)
Many-Body Theory of Nuclear Reactions—Yukap Hahn. 174, 1168 (1968)
Single Separable Potential with Attraction and Repulsion—Frank Tabakin. 174, 1208 (1968)
Causality in $S$-Matrix Theory—Colston Chandler. 174, 1749 (1968)
Calculation of Elastic Scattering Amplitude by Conformal Mapping—György Steinbrecher. 174, 1794 (1968)
Dynamical Groups and the Bethe-Salpeter Equation—E. Kyriakopoulos. 174, 1846 (1968)
Optimized Polynomial Expansion for Scattering Amplitudes—R. E. Cutkosky and B. B. Deo. 174, 1859 (1968)
Kinematical Constraints on Helicity Amplitudes—Jeffrey E. Mandula. 174, 1948 (1968)
Inelastic Effects in $P_{11}$-State $\pi N$ Scattering—Kwok Maw Ong. 174, 1977 (1968)
Analytic Continuation of an Amplitude—W. J. Abbe and G. A. Gary. 174, 2015 (1968)
Relativistic Three-Body Theory with Applications to $\pi$-$N$ Scattering—R. Aaron, R. D. Amado, and J. E. Young. 174, 2022 (1968)
Many-Level Formula for Scattering from Extremely Strong Square Potentials—S. Tani. 174, 2054 (1968)
Kinematic Constraints on Helicity Amplitudes—Henry P. Stapp. 174, 2091 (1968)
Erratum: Existence Proof by a Fixed-Point Theorem for Solutions of the Low Equation—Robert L. Warnock. [170, 1323 (1968)] 174, 2169 (1968)
Rearrangement Collisions: Effect of Core Terms, Nonorthogonality, and Conservation of Particle Flux on Approximate Theories—Donald G. Truhlar, David C. Cartwright, and Aron Kuppermann. 175, 113 (1968)
Analysis of the Harris Variational Method in Scattering Theory—R. K. Nesbet. 175, 134 (1968)
Theory of High-Energy Ion-Atom Collisions with Electron Exchanges—Yukap Hahn. 175, 197 (1968)
Multiple Scattering and the Inverse Albedo Problem—S. Pahor. 175, 218 (1968)
Regge-Type Representations for Coulomb-Nuclear $S$ Matrix—C. S. Shastry and R. K. Satpathy. 175, 1544 (1968)
Coherent Soft-Photon States and Infrared Divergences. IV. The Scattering Operator—T. W. B. Kibble. 175, 1624 (1968)
Puzzle of Regge Dips—Ralph Roskies. 175, 1933 (1968)
Eigenvectors for the Partial-Wave "Crossing Matrices"—A. P. Balachandran, W. J. Meggs, and P. Ramond. 175, 1974 (1968)
$n$-Particle Kinematics and a Generalized Partial-Wave Analysis—William H. Klink and Granville J. Smith II. 175, 2010 (1968)
Structure of Unitary Scattering Amplitudes. II.—Arthur W. Martin. 175, 2155 (1968)
Quasidiffraction Scattering and Selection Rules for Spin and Parity—L. Resnick. 175, 2185 (1968)
Analyticity and Broken $O(4)$ Symmetry—J. B. Bronzan, C. Edward Jones, and P. K. Kuo. 175, 2200 (1968)
High-Energy Scattering at Moderately Large Angles—L. I. Schiff. 176, 1390 (1968)
Maximum Number of Binary Collisions for Three Relativistic Point Particles—G. Doolen. 176, 1541 (1968)
Simultaneous Partial-Wave Expansion in the Mandelstam Variables: The Group $SU(3)$—A. P. Balachandran, W. J. Meggs, J. Nuyts, and P. Ramond. 176, 1700 (1968)
Upper and Lower Bounds on Scattering Lengths for Static Potentials—A. M. Arthurs. 176, 1730 (1968)
Kinematic Singularity Structure of Amplitudes for a Four-Particle Process with One Massless Particle—S. R. Cosslett. 176, 1782 (1968)
Off- and On-Shell Analyticity of Three-Particle Scattering Amplitudes—D. D. Brayshaw. 176, 1855 (1968)
Three-Body Interaction Effects in High-Energy Scattering from Deuterons—David R. Harrington. 176, 1982 (1968)
$O(4)$ Expansion of Off-Shell Scattering Amplitudes—W. R. Frazer, F. R. Halpern, H. M. Lipinski, and D. R. Snider. 176, 2047 (1968)
Regge-Pole Eikonal Theory of Small-Angle Pion-Nucleon Scattering—Richard C. Arnold and Maurice L. Blackmon. 176, 2082 (1968)
High-Energy Scattering by Nuclei—Edward A. Remler. 176 2108 (1968)
Low-Energy Compton Scattering by Arbitrary-Spin Targets—Ira J. Kalet. 176, 2135 (1968)
Proposed Test of Toller $\omega$ Dependence of Two-Reggeon-One-Particle Vertex Functions—Richard A. Morrow. 176, 2147 (1968)
Relation between the Damping of Large Transverse Momenta in Elastic and Inelastic Collisions from Unitarity—D. S. Narayan. 176, 2154 (1968)
Erratum: Solutions of the Bethe-Salpeter and $N/D$ Equations—K. V. Vasavada. [165, 1830 (1968)] 176, 2167 (1968)

## 65.5 Asymptotic Behavior with Energy

$K_2^0+p \rightarrow K_1^0+p$ and the Regge Trajectory of the $\omega$ Meson—Frederick J. Gilman. 171, 1453 (1968)
Daughter Regge Trajectory in a Field-Theory Model. II—Arthur R. Swift. 171, 1466 (1968)

**Properties of Mandelstam Cuts**—D. I. Olive and J. C. Polkinghorne. 171, 1475 (1968)

**Regge Poles for Spinless Particles in the Backward Direction**—Emmanuel A. Paschos. 171, 1620 (1968)

**Superconvergence and Regge Poles. I. Odd-Signature Exchanges**—M. G. Olsson. 171, 1681 (1968)

**A Sum Rule Based on Unitarity**—Farzam Arbab and Richard C. Slansky. 171, 1785 (1968)

**Asymptotic Vertex Function in a Crossing-Symmetric Bootstrap Model of the Hadrons**—John Harte. 171, 1825 (1968)

**Erratum: Construction of Solutions to Superconvergence Relations**—D. Atkinson and M. B. Halpern. [166, 1724 (1968)] 171, 1834 (1968)

**Diffraction-Disassociation Model of Very-High-Energy Nucleon-Nucleon Interactions and the Diffusion of Cosmic Rays through the Atmosphere**—Robert K. Adair. 172, 1370 (1968)

**Feynman-Diagram Models of Regge-Pole Conspiracies**—R. Blankenbecler, R. L. Sugar, and J. D. Sullivan. 172, 1451 (1968)

**Covariant Version of the Bjorken Limit**—P. Olesen. 172, 1461 (1968)

**Bounds for Coupling Constants in the Multi-Regge Model**—K. Kajantie. 172, 1470 (1968)

**$O(4)$, Off-Shell $N\bar{N}$ Scattering, and Massless Pions**—A. H. Mueller. 172, 1516 (1968)

**Superconvergent Dispersion Relation and Low-Energy Kaon-Proton Interaction**—Yu-Chien Liu. 172, 1564 (1968)

**High-Energy Proton-Proton Scattering and Nucleon Structure: The Scalar Interaction in $O(4,2)$**—A. O. Barut and Dennis Corrigan. 172, 1593 (1968)

**Determination of Vacuum Regge Poles and Cuts**—Terence W. Rogers and John H. Schwarz. 172, 1595 (1968)

**Sum-Rule Constraints on Baryon Regge Trajectories**—P. B. James. 172, 1602 (1968)

**Reggeization of Quark Number**—R. Delbourgo, Abdus Salam, and J. Strathdee. 172, 1727 (1968)

**Modified Dispersion Relations and $\pi\pi$ Scattering**—David J. George, Barbara Hale, and Arnold Tubis. 172, 1740 (1968)

**Stationary Expectation Values and Slopes of Daughter Regge Trajectories for the Bethe-Salpeter Equation**—Rabinder N. Madan, Richard W. Haymaker, and R. Blankenbecler. 172, 1788 (1968)

**Impact Parametrization of the Scattering Amplitude**—Ngee-Pong Chang. 172, 1796 (1968)

**Two-Pion-Exchange Theory. Nucleon-Nucleon Scattering**—P. C. M. Yock. 172, 1844 (1968)

**Polarization in $\pi^- p \to \eta n$, the Double-Pole $A_2$, and a Possible Pion Conspirator**—D. M. Austin, J. V. Beaupre, and K. E. Lassila. 173, 1573 (1968)

**Asymptotic Behavior of Form Factors for Some Composite Models**—M. Ciafaloni and P. Menotti. 173, 1575 (1968)

**Asymptotic Behavior of Amplitudes for Meson Photoproduction**—H. G. Dosch. 173, 1595 (1968)

**Equal-Mass Conspiracy Relations as the Limit of the Unequal-Mass Case**—John D. Stack. 173, 1644 (1968)

**Regge Behavior and the Cerulus-Martin Lower Bound of High-Energy Scattering**—Tetsuo Sawada. 173, 1716 (1968)

**Study of $\pi N$ and $KN$ Elastic and Inelastic Scatterings and their Polarizations by a Multiple-Regge-Pole Model**—Fei S. Chen-Cheung and Timothy Roth. 173, 1768 (1968)

**Asymptotic Sum Rules**—Myron Bander and J. D. Bjorken. 174, 1704 (1968)

**Application of Modified Dispersion Relations to the Forward $KN$ Crossing-Even Scattering Amplitude**—David J. George and Arnold Tubis. 174, 1871 (1968)

**Regge Parameters in Crossing-Even $KN$ Scattering**—David J. George and Arnold Tubis. 174, 1875 (1968)

**Large-Angle Proton-Proton Scattering and the Pomeranchuk Trajectory**—Kerson Huang and Stephen Pinsky. 174, 1915 (1968)

**$O(4)$ Symmetry and the Regge Trajectory of the Pion**—W. R. Frazer, H. M. Lipinski, and D. R. Snider. 174, 1932 (1968)

**$O(3,1)$ Symmetry and Conspiracy in Photoproduction of Pions at High Energy**—L. M. Nath. 174, 1942 (1968)

**Extension of Axiomatic Analyticity Properties for Particles with Spin, and Proof of Superconvergence Relations**—Gilbert Mahoux and Andre Martin. 174, 2140 (1968)

**High-Energy Large-Angle Proton-Proton Scattering**—Ngee-Pong Chang. 175, 1741 (1968)

**High-Energy Polarized-Photon Reactions**—Robert L. Thews. 175, 1749 (1968)

**Regge Poles and Finite-Energy Sum Rules for Kaon-Nucleon Scattering**—Guru Vachan Dass and C. Michael. 175, 1774 (1968)

**Model of High-Energy Elastic Scattering and Diffractive Excitation Processes in Hadron-Hadron Collisions**—T. T. Chou and C. N. Yang. 175, 1832 (1968)

**Daughters, Conspiracies, and Lorentz Symmetry**—Khalil M. Bitar and Graham L. Tindle. 175, 1835 (1968)

**Factorization and Constraints in Regge-Pole Theory**—A. Capella, A. P. Contogouris, and J. Tran Thanh Van. 175, 1892 (1968)

**Regge-Pole Model with the $M = 1$ Pion in $\pi^+ p \to \rho^0 \Delta^{++}$ and $\pi^+ p \to \rho^+ p$ Scattering**—Farzam Arbab and Richard C. Brower. 175, 1991 (1968)

**Pion Photoproduction, $NN$ Scattering, and Photoproduction Sum Rules**—Richard C. Brower and Jan W. Dash. 175, 2014 (1968)

**Crossing-Symmetric Rising Regge Trajectories**—Shu-Yuan Chu, Gary Epstein, Peter E. Kaus, Richard C. Slansky, and Fredrik Zachariasen. 175, 2098 (1968)

**Analyticity and the Daughter Structure of Conspiring Regge-Pole Families**—Lorella Jones and Harvey K. Shepard. 175, 2117 (1968)

**Continuous-Moment Sum Rules and Pion Conspiracy in Photoproduction**—K. Raman and Kashyap V. Vasavada. 175, 2191 (1968)

**Theories at Infinite Momentum**—K. Bardakci and M. B. Halpern. 176, 1686 (1968)

**Regge Secondary Trajectories**—G. C. Fox and L. Sertorio. 176, 1739 (1968)

**Photon Scattering from Bound Atomic Systems at Very High Energy**—M. L. Goldberger and F. E. Low. 176, 1778 (1968)

**Factorization, Kinematic Singularities, and Conspiracies**—Farzam Arbab and J. D. Jackson. 176, 1796 (1968)

**Conspiracy and Counterconspiracy in Equal-Mass Scattering**—J. H. Weis. 176, 1822 (1968)

**Intersecting Regge Trajectories in a Field-Theory Model**—Arthur R. Swift. 176, 1848 (1968)

**Effect of the Existence of an Elementary Quark on High-Energy Scattering**—Stuart D. Anderson. 176, 1881 (1968)

**Bootstrap of Meson Trajectories from Superconvergence**—M. Ademollo, H. R. Rubinstein, G. Veneziano, and M. A. Virasoro. 176, 1904 (1968)

**Interacting Rarita-Schwinger Field**—Gyan Mohan. 176, 1931 (1968)

**Argand-Diagram Loops and Regge Poles**—P. D. B. Collins, R. C. Johnson, and G. G. Ross. 176, 1952 (1968)

**Regge Asymptotic Behavior and the Bethe-Salpeter Equation**—Richard A. Brandt and Martin Feinroth. 176, 1985 (1968)

**$K^*(890)$ Photoproduction in the Regge-Pole Model**—N. S. Thornber. 176, 1998 (1968)

**Multi-Reggeon Behavior of Production Amplitudes**—I. T. Drummond. 176, 2003 (1968)

Sums of Direct-Channel Regge-Pole Contributions and Crossing Symmetry—N. N. Khuri. 176, 2026 (1968)
Cancellation of Divergences in Reggeized Electromagnetic Mass Differences—Arnulf Rabl. 176, 2034 (1968)
Connection between the Toller Quantum Number $M$ and the Small-$t$ Behavior of the Asymptotic $S$-Channel Helicity Amplitudes—John F. Gunion and H. M. Lipinski. 176, 2045 (1968)
Meson-Baryon and Baryon-Baryon Scattering in Reggeized $U(6)\otimes U(6)$ Theory—R. Delbourgo and Harun-ar Rashid. 176, 2074 (1968)
Multiperipheral Bootstrap Model—G. F. Chew and A. Pignotti. 176, 2112 (1968)

## 66 SYMMETRIES AND INVARIANCE PRINCIPLES

Formal Breakdown of Lorentz Invariance in Two-Dimensional Field Theories—G. S. Guralnik and C. R. Hagen. 171, 1431 (1968)
Coupling of the Spacelike and Timelike Wave Functions at Infinite Momentum—Shau-Jin Chang and L. O'Raifeartaigh. 171, 1587 (1968)
Wave Equations with Broken $U(3,1)$ Symmetry—Ernest E. H. Shin. 171, 1652 (1968)
Quantized Gauge Field Theory of Chiral Symmetry—York-Peng Yao. 171, 1702 (1968)
Relativistic Lagrangian Field Theory for Composite Systems—Christian Fronsdal. 171, 1811 (1968)
Local Field Theory and Isospin Invariance. III. Interactions of Self-Conjugate Isofermion Fields—P. Carruthers. 172, 1406 (1968)
Majorana Equations for Composite Systems—G. Bisiacchi, P. Budini, and G. Calucci. 172, 1508 (1968)
Wave Equations for Neutral Particles of Arbitrary Spin—D. D. H. Yee. 172, 1539 (1968)
Static $SU(6)$ and Fundamental Substitution—Shin Ishida and P. Roman. 172, 1684 (1968)
Some Aspects of Field Symmetries—H. Scharfstein. 172, 1828 (1968)
$O(4)$ Symmetry in Feynman Amplitudes—Yoichi Iwasaki. 173, 1608 (1968)
Lorentz Invariance, Local Field Theory, and Faster-than-Light Particles—M. E. Arons and E. C. G. Sudarshan. 173, 1622 (1968)
Kinematic Singularities and Constraints of Helicity Amplitudes—T. L. Trueman. 173, 1684 (1968)
Note on Nonlinear Realizations of Chiral Symmetry—William Sollfrey. 173, 1805 (1968)
Does Lorentz-Invariance Imply Causality?—Michael M. Broido and John G. Taylor. 174, 1606 (1968)
Timelike Reflection: the Coupling between Time Reversal and the Poincaré Group—Gordon N. Fleming. 174, 1620 (1968)
Coupling between the Poincaré Group and Space-Time or Spacelike Reflections on Hyperplanes—James T. Miller, Jr., and Gordon N. Fleming. 174, 1625 (1968)
Bjorken Limit and Pole Dominance. I. The $\omega\rho\pi$ System and the Algebra of Fields—Stanley G. Brown and Geoffrey B. West. 174, 1777 (1968)
Bjorken Limit and Pole Dominance. II. Virtual $\pi\rho$ Scattering—Stanley G. Brown and Geoffrey B. West. 174, 1786 (1968)
Dynamical Groups and the Bethe-Salpeter Equation—E. Kyriakopoulos. 174, 1846 (1968)
Kinematical Constraints on Helicity Amplitudes—Jeffrey E. Mandula. 174, 1948 (1968)
Intrinsic Invariance Groups, Mass Operators, and Linear Wave Equations—Kenneth Rafanelli. 175, 1761 (1968)
Daughters, Conspiracies, and Lorentz Symmetry—Khalil M. Bitar and Graham L. Tindle. 175, 1835 (1968)
Structure of Three-Point Functions from $SU(3)\otimes SU(3)$ Algebra—Ira S. Gerstein, Howard J. Schnitzer, and Steven Weinberg. 175, 1873 (1968)
$n$-Particle Kinematics and a Generalized Partial-Wave Analysis—William H. Klink and Granville J. Smith II. 175, 2010 (1968)
Transformation Properties and Relativistic Equations for Spin-One Elementary Systems—L. Fonda and G. C. Ghirardi. 175, 2082 (1968)
Quark Interactions and Nucleon Form Factors—G. M. Cicuta, G. Marchesini, and A. Scotti. 175, 2113 (1968)
A Path Integral for Spin—Lawrence Schulman. 176, 1558 (1968)
Possible Classification of Exchange-Degenerate Trajectories—Akbar Ahmadzadeh and Richard J. Jacob. 176, 1719 (1968)

### 66.2 Applications to Weak and Electromagnetic Interactions

$A_1$-$\rho$-$\pi$ System and $\pi \to l\nu\gamma$ Decay—Riazuddin and Fayyazuddin. 171, 1428 (1968)
Parity-Conserving Hyperon Nonleptonic Decays in $SU(3)$—M. O. Taha. 171, 1481 (1968)
Embedding of $SU(3)$ in $SU(8)$—D. S. Carlstone. 171, 1527 (1968)
Nonleptonic Decays of Hyperons and Current Algebra—Francis C. P. Chan. 171, 1543 (1968)
Renormalization of Weak Form Factors, and the Cabibbo Angle—H. R. Quinn and J. D. Bjorken. 171, 1660 (1968)
$\Delta I=\frac{1}{2}$ Rule in Current-Current Models of $CP$ Violation—Barry R. Holstein. 171, 1668 (1968)
A Mass-Splitting Theorem for General Definitions of Mass—A. Böhm and L. O'Raifeartaigh. 171, 1698 (1968)
Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: General Features—P. Babu, S. Frautschi, and N. S. Thornber. 172, 1389 (1968)
Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: Detailed Calculation—N. S. Thornber. 172, 1395 (1968)
Tests for $|\Delta I|\leq 1$ in Electromagnetic Interactions—Ernest E. Bergmann. 172, 1441 (1968)
$K_{l3}$-Decay Form Factors, Current Algebra, and Subtracted Dispersion Relations. II—Norman H. Fuchs. 172, 1532 (1968)
$\kappa$-Meson Mass and Weak-Decay Parameters from a Study of $K_{l3}$ Form Factors—Jacob E. Mackey, J. Michael McKisic, David M. Scott, and Walter W. Wada. 172, 1590 (1968)
Broken $SU(3)$ Symmetry, Sum Rules, and the Magnetic Moments of the Baryons—T. P. Cheng and Heinz Pagels. 172, 1635 (1968)
Current Algebra and Photoproduction of Pions—M. S. Bhatia and P. Narayanaswamy. 172, 1742 (1968)
$(K\pi)$ Phase Shifts from a Current-Algebra Model—Antonio Pagnamenta and B. Renner. 172, 1761 (1968)
Erratum: $K\pi$ Scattering, $\kappa$ Meson, and Current Algebra—Probir Roy. [168, 1708 (1968)] 172, 1850 (1968)
Inelastic Electron Scattering in the Symmetric Quark Model. II. Coulomb Potential—N. S. Thornber. 173, 1414 (1968)
Invariant Amplitudes for Photon Processes—W. A. Bardeen and Wu-Ki Tung. 173, 1423 (1968)
Unitarity Corrections to Pole Dominance in Spectral-Function Sum Rules—W. S. Lam and K. Raman. 173, 1497 (1968)

Models of Weak Interactions Mediated by Vector Bosons—G. Segrè. 173, 1730 (1968)
Ratio of Axial-Vector to Vector Contributions in $K \to l\nu\gamma$ Decay—A. Q. Sarker. 173, 1749 (1968)
$K_{l3}$ Form Factors in Current Algebra with Hard Pion and Kaon—Riazuddin and A. Q. Sarker. 173, 1752 (1968)
Structure-Dependent Axial-Vector Form Factor in Charged-Pion Radiative Decay—J. S. Vaishya. 173, 1757 (1968)
Two-Pole Model for the $\eta_{3\pi}$ Decays—Suk Koo Yun. 173, 1764 (1968)
Test of Time-Reversal Invariance via a $\beta$-$\gamma$-$\gamma$ Angular Correlation in $^{106}$Rh-$^{106}$Pd—R. B. Perkins and E. T. Ritter. 174, 1426 (1968)
Weak Parity-Nonconserving Potentials—D. Tadić. 174, 1694 (1968)
Electromagnetic Properties of Baryons in a Quark-Diquark Model with Broken $SU(6)$—James Carroll, D. B. Lichtenberg, and J. Franklin. 174, 1681 (1968)
Method of Calculating the Axial-Vector Current Coupling Constants for Lepton Decays of Baryons—M. K. Au-Yang. 174, 1731 (1968)
Chiral Dynamics for High-Spin Baryons and an Application to Double-Pion Photoproduction—H. W. Huang. 174, 1799 (1968)
Sum Rules for Weak $BB\pi$ Amplitudes—E. Fischbach and K. Trabert. 174, 1843 (1968)
Pole Models for $S$-Wave Hyperon Decay—D. S. Carlstone, S. P. Rosen, and S. Pakvasa. 174, 1877 (1968)
Current Commutation Relations in $R(11)$—L. L. Smalley and D. W. Joseph. 174, 1937 (1968)
$O(3,1)$ Symmetry and Conspiracy in Photoproduction of Pions at High Energy—L. M. Nath. 174, 1942 (1968)
$T$-Violation Effects and Final-State Interactions—G. Karpman, R. Leonardi, and F. Strocchi. 174, 1957 (1968)
$O(4)$ Symmetry of the Hydrogen Atom and the Lamb Shift—Michael Lieber. 174, 2037 (1968)
Hard-Kaon Processes and the Spectral-Function Sum Rules—Yoshiaki Ueda. 174, 2082 (1968)
Feynman Rules for Electromagnetic and Yang-Mills Fields from the Gauge-Independent Field-Theoretic Formalism—Stanley Mandelstam. 175, 1580 (1968)
Chiral $SU(3) \otimes SU(3)$ Three-Point Function: Single-Particle Approximation—Ira S. Gerstein and Howard J. Schnitzer. 175, 1876 (1968)
Momentum-Dependent $K_{\ell 4}$-Decay Form Factors—Ranabir Dutt, K. C. Gupta, and J. S. Vaishya. 175, 1884 (1968)
Corrections to the Coleman-Glashow Sum Rule—Stephen Brook Fels. 175, 1895 (1968)
$SU(6)_W$ and High-Energy Photoproduction—S. Meshkov and R. Ponzini. 175, 2030 (1968)
Stress-Tensor–Current Commutators, Electromagnetic and Weak Corrections to Current Commutators, and Sum Rules—R. Jackiw. 175, 2058 (1968)
Phenomenological Analysis of Weak-Radiative Decay of the $K^+$ Meson and $CP$-Noninvariant Effects—Y. Singh. 175, 2214 (1968)
Renormalization of the Strangeness-Changing Axial-Vector Coupling Constants—C. H. Chan and F. T. Meiere. 175, 2222 (1968)
Exactly Soluble Nonrelativistic Model of Particles with Both Electric and Magnetic Charges—Daniel Zwanziger. 176, 1480 (1968)
A Path Integral for Spin—Lawrence Schulman. 176, 1558 (1968)
Low-Energy Theorems for $e^4$ Compton Scattering Amplitudes—T. P. Cheng. 176, 1674 (1968)
$CP$ Violation and Coherent Decays of Kaon Pairs—Harry J. Lipkin. 176, 1715 (1968)
Relation of Charged-$K$ Decay to $CP$ Violation—Robert M. Delaney and Daniel J. Welling. 176, 1841 (1968)
$K_{l4}$ Form Factors in Current Algebra with Hard Pions and Kaon—A. Q. Sarker. 176, 1959 (1968)
Current Algebra and the Vector Form Factor in $K_{l4}$ Decays—A. Q. Sarker. 176, 1971 (1968)
Study of the Decays $K \to l\bar{l}$ and $K \to \pi l\bar{l}$—A. Pais and S. B. Treiman. 176, 1974 (1968)
Scalar Nonet, Semileptonic $K$ Decays, and Spectral-Function Sum Rules—Binayak Dutta-Roy and Alexander Martin. 176, 1979 (1968)
$K \to 2\pi$ Phenomenology with Small $CP$ Nonconservation—L. David Roper. 176, 2120 (1968)
Virtual-Photon–Pion Scattering, Hard-Pion Current Algebra, and Dispersion Relations—K. C. Gupta and J. S. Vaishya. 176, 2125 (1968)
Compton Scattering by Spin-One Particles—Wu-Ki Tung. 176, 2127 (1968)
Erratum: Current Algebra and Photoproduction of Pions—M. S. Bhatia and P. Narayanaswamy. [172, 1742 (1968)] 176, 2167 (1968)

## 66.4 Applications to Strong Interactions

Interference of Kaon Resonances—G. L. Kane and H. S. Mani. 171, 1533 (1968)
Induction of Symmetries for a Set of Mesons of Both Parities—Richard H. Capps. 171, 1591 (1968)
Pion-Nucleon Scattering and $SO(4)$ Symmetry—N. W. Macfadyen. 171, 1691 (1968)
A Mass-Splitting Theorem for General Definitions of Mass—A. Bõhm and L. O'Raifeartaigh. 171, 1698 (1968)
Sum Rules from Charge–Charge-Density and Charge-Charge Commutators—S. Matsuda and S. Oneda. 171, 1743 (1968)
Enhancement of $SU(3)$ Breakings and Regge Trajectories—Mahiko Suzuki. 171, 1791 (1968)
Quark Model and Masses of Baryons and Mesons—S. P. Misra and C. V. Sastry. 172, 1402 (1968)
Paraquarks, Structural Saturation, and Hard Core—A. N. Mitra and S. A. Moszkowski. 172, 1474 (1968)
Consequences of a $QQ\bar{Q}$ Model for Meson-Baryon Processes—S. Das Gupta, V. K. Gupta, and A. N. Mitra. 172, 1482 (1968)
$O(4)$, Off-Shell $N\bar{N}$ Scattering, and Massless Pions—A. H. Mueller. 172, 1516 (1968)
General Form of Representations of the Current Algebra in the Two-Quark Model—Roger C. Hilb. 172, 1521 (1968)
Nonexistence of Self-Conjugate Particles with Half-Integral Isospin—D. D. H. Yee. 172, 1537 (1968)
Canonical Representation of Sugawara's Theory—K. Bardakci and M. B. Halpern. 172, 1542 (1968)
Spectral-Function Sum Rules with Symmetry Breaking—Tomoya Akiba and Kyungsik Kang. 172, 1551 (1968)
High-Energy Proton-Proton Scattering and Nucleon Structure: The Scalar Interaction in $O(4,2)$—A. O. Barut and Dennis Corrigan. 172, 1593 (1968)
Spectral Representations for Symmetry-Breaking Parameters—Robert Perrin. 172, 1675 (1968)
Reggeization of Quark Number—R. Delbourgo, Abdus Salam, and J. Strathdee. 172, 1727 (1968)
Spectral-Function Sum Rules and the Ratio $f_K/f_\pi$—Riazuddin and Fayyazuddin. 172, 1737 (1968)
Model for Pion $S$-Wave Phase Shifts from Current Algebra and Partial Conservation of Axial-Vector Current—A. M. S. Amatya, A. Pagnamenta, and B. Renner. 172, 1755 (1968)
$(K\pi)$ Phase Shifts from a Current-Algebra Model—Antonio Pagnamenta and B. Renner. 172, 1761 (1968)
A Model of Baryons Made of Quarks with Hidden Spin—Jerrold Franklin. 172, 1807 (1968)

Large-Angle Scattering and the Fifth Interaction—Y. Ne'eman 172, 1818 (1968)

Simultaneous "Partial-Wave" Expansion in the Mandelstam Variables: Crossing Symmetry for Partial Waves—A. P. Balachandran and J. Nuyts. 172, 1821 (1968)

$SU(3)$-Symmetry Breaking in a Bethe-Salpeter Bootstrap Model—E. Golowich. 172, 1834 (1968)

Erratum: Generalized Pole-Dominance Hypothesis, Current Algebra, and $S$-Wave $K^+p$ Scattering—Probir Roy. [162, 1644 (1967)] 172, 1849 (1968)

Erratum: Symmetric Quark Model of Baryon Resonances—O. W. Greenberg and M. Resnikoff. [163, 1844 (1967)] 172, 1850 (1968)

Theory of Currents, $\sigma$ Model, and the Spherical Top in the Internal Space—H. Sugawara and M. Yoshimura. 173, 1419 (1968)

Strongly Decaying Particles and Relativistic Invariance—François Lurçat. 173, 1461 (1968)

Unitarity Corrections to Pole Dominance in Spectral-Function Sum Rules—W. S. Lam and K. Raman. 173, 1497 (1968)

Statistical Model for High-Energy Reactions—L. L. Foldy, H. Kottler, D. R. Speiser, and J. Weyers. 173, 1517 (1968)

Current Algebra, Crossing Symmetry, and Unitarity for $s$-Wave $\pi\pi$ Scattering—K. Datta, K. C. Gupta, and V. S. Varma. 173, 1549 (1968)

Broken-Symmetry Model of Meson Interactions—L. A. Copley, D. K. Elias, and D. Masson. 173, 1552 (1968)

$S$-Matrix Approach to Internal Symmetries. II—S. M. Roy. 173, 1671 (1968)

Three-Particle Final States in the Quark Model—Sutapa Das Gupta. 173, 1745 (1968)

Sum Rules for Meson-Baryon Scattering from Asymptotic Symmetry Requirements—V. P. Seth, B. K. Agarwal, and Y. M. Gupta. 173, 1759 (1968)

Rate of $A_1 \to \rho\pi$ from Asymptotic Chiral Symmetry—A. Zee. 173, 1788 (1968)

Scattering Model with Crossing Symmetry and Minimal Inelastic Effects—Franklin F. K. Cheung and John S. Toll. 173, 1791 (1968)

Parity Conservation in the Reaction $T(d,n)He^4$—D. C. Bonar, C. W. Drake, R. D. Headrick, and V. W. Hughes. 174, 1200 (1968)

Asymptotic Sum Rules—Myron Bander and J. D. Bjorken. 174, 1704 (1968)

Chiral Dynamics for High-Spin Baryons and an Application to Double-Pion Photoproduction—H. W. Huang. 174, 1799 (1968)

Chiral Symmetry from Divergence Requirements—D. B. Fairlie and K. Yoshida. 174, 1816 (1968)

Self-Consistent Calculation of Vector- and Pseudoscalar-Meson Mass Splittings—S. L. Cohen. 174, 1867 (1968)

$O(4)$ Symmetry and the Regge Trajectory of the Pion—W. R. Frazer, H. M. Lipinski, and D. R. Snider. 174, 1932 (1968)

Current Algebra and Double-Pion Photoproduction—S. C. Bhargava. 174, 1969 (1968)

Derivation of Intermultiplet Mass Formulas from the Chiral $SU(3) \otimes SU(3)$ Charge Algebra—S. Matsuda and S. Oneda. 174, 1992 (1968)

Hard-Pion Current-Algebra Calculation of Meson Processes—Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 1999 (1968)

Application of Hard-Pion Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 2008 (1968)

Sum Rules Involving the $\rho$ and $A_1$ Mesons and the $A_1 \to \rho + \pi$ Decay—S. Matsuda and S. Oneda. 174, 2106 (1968)

Splitting, Mixing, and Small Perturbations in $SU(3)$ Multiplets of Vector Mesons—L. F. Cook and H. L. Watson. 174, 2113 (1968)

Isospin and $U$-Spin Dependence of Hadron-Nucleon Total Cross Sections—Harry J. Lipkin. 174, 2151 (1968)

Lorentz-Pole Model and Polarization in High-Energy Charge-Exchange Pion-Nucleon Scattering—N. G. Antoniou, S. R. Komy, C. D. Palev, and M. Samiullah. 175, 1757 (1968)

Derivation of the Mass and Spin Spectrum for Mesons and Baryons—A. Böhm. 175, 1767 (1968)

Analyticity and Broken $SL(2, C)$ Symmetry for Regge Families—P. K. Kuo and James F. Walker. 175, 1794 (1968)

Hard-Pion Current-Algebra Calculation of Meson Processes—$N$-Point Functions—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1802 (1968)

Application of Hard-Pion Four-Point Functions to Pion-Pion Scattering—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1820 (1968)

Vertex-Strength-Algebra Treatment of Vector-Meson Photoproduction—A. C. Hirshfeld and L. P. Horwitz. 175, 1865 (1968)

Chiral $SU(3) \otimes SU(3)$ Three-Point Function: Single-Particle Approximation—Ira S. Gerstein and Howard J. Schnitzer. 175, 1876 (1968)

Eigenvectors for the Partial-Wave "Crossing Matrices"—A. P. Balachandran, W. J. Meggs, and P. Ramond. 175, 1974 (1968)

Reanalysis of the Lowest-Mass Negative-Parity Baryon Resonances Using the Symmetric Quark Model—D. R. Divgi and O. W. Greenberg. 175, 2024 (1968)

Decays of Negative-Parity Baryons in a Quark Model—D. R. Divgi. 175, 2027 (1968)

$SU(6)_W$ and High-Energy Photoproduction—S. Meshkov and R. Ponzini. 175, 2030 (1968)

Analyticity and the Daughter Structure of Conspiring Regge-Pole Families—Lorella Jones and Harvey K. Shepard. 175, 2117 (1968)

Behavior of Current Divergences under $SU_3 \times SU_3$—Murray Gell-Mann, R. J. Oakes, and B. Renner. 175, 2195 (1968)

Analyticity and Broken $O(4)$ Symmetry—J. B. Bronzan, C. Edward Jones, and P. K. Kuo. 175, 2200 (1968)

Simultaneous Partial-Wave Expansion in the Mandelstam Variables: The Group $SU(3)$—A. P. Balachandran, W. J. Meggs, J. Nuyts, and P. Ramond. 176, 1700 (1968)

Scalar Density Terms, $K\pi$ and $KK$ Scattering Lengths, and a Symmetry-Breaking Parameter—Richard W. Griffith. 176, 1705 (1968)

Interference, Mixing, and Angular Correlations in Decays of Boson Resonances—Harry J. Lipkin. 176, 1709 (1968)

Representation Mixing and $SU_3$ Symmetry Breaking in the $\frac{1}{2}^-$ Baryon Octet—Peter N. Dobson, Jr. 176, 1757 (1968)

Decays of Odd-Parity Baryon Resonances—J. C. Carter and M. E. M. Head. 176, 1808 (1968)

Chiral Lagrangian Calculation of Pion-Nucleon Scattering Lengths—R. D. Peccei. 176, 1812 (1968)

Complex $\bar{K}N$ Scattering Lengths and Current Algebra—Debabrata Basu, S. N. Biswas, and K. Datta. 176, 1835 (1968)

Rescattering Effects in the Quark Model for Meson-Baryon Couplings—J. D. Anand, V. S. Bhasin, and A. N. Mitra. 176, 1891 (1968)

Meson Bootstraps for Unnatural-Parity States—M. Bishari, H. R. Rubinstein, A. Schwimmer, and G. Veneziano. 176, 1926 (1968)

Currents as Dynamical Variables—Charles M. Sommerfield. 176, 2019 (1968)

Connection between the Toller Quantum Number $M$ and the Small-$t$ Behavior of the Asymptotic $S$-Channel Helicity Amplitudes—John F. Gunion and H. M. Lipinski. 176, 2045 (1968)

$O(4)$ Expansion of Off-Shell Scattering Amplitudes—W. R. Frazer, F. R. Halpern, H. M. Lipinski, and D. R. Snider. 176, 2047 (1968)

$O(4)$ Symmetry, $N\bar{N}$ Scattering, and the Regge Trajectory of the Pion—H. M. Lipinski and D. R. Snider. 176, 2054 (1968)

Meson-Baryon and Baryon-Baryon Scattering in Reggeized $U(6)\otimes U(6)$ Theory—R. Delbourgo and Harun-ar Rashid. 176, 2074 (1968)

## 70 ERRATA

Erratum: Study of $H_2^+ + H_2 \rightarrow H_3^+ + H$ Using Merging Beams—R. H. Neynaber and S. M. Trujillo. [167, 63 (1968)] 171, 282 (1968)

Erratum: Ultrasonic Attenuation of Pure Strong-Coupling Superconductors—James W. F. Woo. [155, 429 (1967)] 171, 610 (1968)

Erratum: Quantum Theory of Spontaneous Parametric Scattering of Intense Light—T. G. Giallorenzi and C. L. Tang. [166, 225 (1968)] 171, 610 (1968)

Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)

Erratum: Investigation of Energy-Band Structures and Electronic Properties of PbS and PbSe—Sohrab Rabii. [167, 801 (1968)] 171, 1114 (1968)

Erratum: Construction of Solutions to Superconvergence Relations—D. Atkinson and M. B. Halpern. [166, 1724 (1968)] 171, 1834 (1968)

Erratum: Quantum Theory of Gravity. I. The Canonical Theory—Bryce S. DeWitt. [160, 1113 (1967)] 171, 1834 (1968)

Erratum: Quantum Theory of Gravity. II. The Manifestly Covariant Theory—Bryce S. DeWitt. [162, 1195 (1967)] 171, 1834 (1968)

Erratum: Quantum Theory of Gravity. III. Applications of the Covariant Theory—Bryce S. DeWitt. [162, 1239 (1967)] 171, 1834 (1968)

Erratum: Effect of Angular Correlation on Nonlinear Refractive Index of Liquids—M. Takatsuji. [165, 171 (1968)] 172, 241 (1968)

Erratum: Kinetic Equation for Drifted Electron Plasma—N. Tzoar. [162, 123 (1967)] 172, 241 (1968)

Erratum: Quantum Theory of Collision-Induced Absorption in Rare-Gas Mixtures—Howard B. Levine. [160, 159 (1967)] 172, 241 (1968)

Erratum: Electrical Resistivity and Thermoelectric Power of CuAu Alloy—K. Teramoto and M. Tachiki. [166, 656 (1968)] 172, 1002 (1968)

Erratum: Optical Properties of Cobalt—A. Y-C. Yu, T. M. Donovan, and W. E. Spicer. [167, 670 (1968)] 172, 1002 (1968)

Erratum: Photoemission Studies of the Electronic Structure of Cobalt—A. Y-C. Yu and W. E. Spicer. [167, 674 (1968)] 172, 1002 (1968)

Erratum: Generalized Hartree-Fock Approximation for Nucleon-Nucleon Scattering—Louis Celenza. [168, 1189 (1968)] 172, 1282 (1968)

Erratum: Perturbed Bound-State Poles in Potential Scattering. II—Y. S. Kim and Kashyap V. Vasavada. [150, 1236 (1966)] 172, 1849 (1968)

Erratum: Generalized Pole-Dominance Hypothesis, Current Algebra, and $S$-Wave $K^+p$ Scattering—Probir Roy. [162, 1644 (1967)] 172, 1849 (1968)

Erratum: $K\pi$ Scattering, $\kappa$ Meson, and Current Algebra—Probir Roy. [168, 1708 (1968)] 172, 1850 (1968)

Erratum: Symmetric Quark Model of Baryon Resonances—O. W. Greenberg and M. Resnikoff. [163, 1844 (1967)] 172, 1850 (1968)

Erratum: New Formulation of the Axially Symmetric Gravitational Field Problem. II—Frederick J. Ernst. [168, 1415 (1968)] 172, 1850 (1968)

Erratum: Recombination of Electrons and Molecular Helium Ions—Gunthard K. Born. [169, 155 (1968)] 173, 325 (1968)

Erratum: Second-Harmonic Generation of Microwave Phonons in Quartz and Sapphire—Paul H. Carr. [169, 719 (1968)] 173, 325 (1968)

Erratum: Calculation of Low-Energy Electron-Atom Transport Cross Sections from Total Cross-Section Measurements—R. L. Fox. [168, 1 (1968)] 173, 325 (1968)

Erratum: A New Type of Wave Function for Li, $Be^+$, and $B^{++}$—William A. Goddard, III. [169, 120 (1968)] 173, 325 (1968)

Erratum: Dynamical Effects of Deuteron Intrabond Jumping in $KD_2PO_4$—V. Hugo Schmidt. [164, 749 (1967)] 173, 630 (1968)

Erratum: Theory of Magnetically Induced Electric Field Gradients in Cubic $Fe^{2+}$—U. Ganiel and S. Shtrikman. [167, 258 (1968)] 173, 630 (1968)

Erratum: Towards a Quantum Many-Body Theory of Lattice Dynamics. II. Collective Fluctuation-Approximation—N. S. Gillis and N. R. Werthamer. [167, 607 (1968)] 173, 918 (1968)

Erratum: Subthreshold Electron Damage in $n$-Type Germanium—Y. Chen and J. W. MacKay. [167, 745 (1968)] 173, 918 (1968)

Erratum: Investigation of Energy-Band Structures and Electronic Properties of PbS and PbSe—Sohrab Rabii. [167, 801 (1968)] 173, 918 (1968)

Erratum: Effective Magnetic Field in Metals—J. I. Kaplan and M. L. Glasser. [170, 649 (1968)] 173, 918 (1968)

Erratum: Application of $\xi$-Limiting Process to Intermediate Bosons—T. D. Lee. [128, 899 (1962)] 173, 1806 (1968)

Erratum: Reggeization of External Particles—M. L. Thiebaux. [170, 1244 (1968)] 173, 1806 (1968)

Erratum: Matrix Elements of the Spin-Spin Interaction for the $f^3$ Electron Configuration—Edith F. Reilly. [170, 1 (1968)] 174, 329 (1968)

Erratum: Semiempirical Electron Correlation in the Carbon Atom—Raymond W. Mires. [155, 1 (1967)] 174, 329 (1968)

Erratum: Electron Tunneling in Metal-Semiconductor Barriers—J. W. Conley, C. B. Duke, G. D. Mahan, and J. J. Tiemann. [150, 466 (1966)] 174, 1082 (1968)

Erratum: Electric Properties of $n$-Type Liquid Alloys of Thallium and Tellurium—Melvin Cutler and Marshall B. Field. [169, 632 (1968)] 174, 1082 (1968)

Erratum: Specific Heats below 3°K of Pure Copper, Silver, and Gold and of Extremely Dilute Gold-Transition-Metal Alloys—Douglas L. Martin. [170, 650 (1968)] 174, 1082 (1968)

Erratum: Threshold Electrodisintegration of the Deuteron—Ronald J. Adler. [169, 1192 (1968)] 174, 2169 (1968)

Erratum: Existence Proof by a Fixed-Point Theorem for Solutions of the Low Equation—Robert L. Warnock. [170, 1323 (1968)] 174, 2169 (1968)

Erratum: Radiative Corrections to $K_{e3}^0$ Decays and the $\Delta I = \frac{1}{2}$ Rule—Edward S. Ginsberg. [171, 1675 (1968)] 174, 2169 (1968)

Erratum: Nuclear Magnetic Resonance and Relaxation of $^{197}Au$ in Gold Metal and $^{109}Ag$ in Gold-Silver Alloys—Albert Narath. [163, 232 (1967)] 175, 696 (1968)

**Erratum: Nuclear Magnetic Resonance and Relaxation in Iridium Metal: The Nuclear Magnetic Dipole Moments of $^{191}$Ir and $^{193}$Ir**—Albert Narath. [165, 506 (1968)] 175, 696 (1968)

**Erratum: Photoemission Study of the Electronic Structure of Wurtzite CdSe and CdS**—J. L. Shay and W. E. Spicer. [169, 650 (1968)] 175, 1232 (1968)

**Erratum: Sum Rules for the Axial-Vector Coupling Constant Renormalization in $\beta$ Decay**—Stephen L. Adler. [140, B736 (1965); 149, 1294(E) (1966)], 175, 2224 (1968)

**Erratum: Precise Theory of the Zeeman Spectrum for Atomic Hydrogen and Deuterium and the Lamb Shift**—Stanley J. Brodsky and Ronald G. Parsons. [163, 134 (1967)] 176, 423 (1968)

**Erratum: Coupled-State Calculations of Proton-Hydrogen Scattering in the Sturmian Representation**—D. F. Gallaher and L. Wilets. [169, 139 (1968)] 176, 423 (1968)

**Erratum: Screened Coulomb Solutions of the Schrödinger Equation**—Carl A. Rouse. [159, 41 (1967)] 176, 423 (1968)

**Erratum: Finite Electronic Partition Function from Screened Coulomb Interactions**—Carl A. Rouse. [163, 62 (1967)] 176, 423 (1968)

**Erratum: Evidence for the $^3\Delta_u \rightarrow B^3\Pi_g$ Transition in $N_2$**—H. L. Wu and W. Benesch. [172, 31 (1968)] 176, 423 (1968)

**Erratum: Surface Effects in the Heisenberg Antiferromagnet**—D. L. Mills and W. M. Saslow. [171, 488 (1968)] 176, 760 (1968)

**Erratum: Role of Longitudinal and Transverse Phonons in Lattice Thermal Conductivity of GaAs and InSb**—C. M. Bhandari and G. S. Verma. [140, A2101 (1965)] 176, 1112 (1968)

**Erratum: Magnetic Interactions between Rare-Earth Ions in Insulators. I. Accurate Electron-Paramagnetic-Resonance Determination of $Gd^{3+}$ Pair-Interaction Constants in $LaCl_3$**—M. T. Hutchings, R. J. Birgeneau, and W. P. Wolf. [168, 1026 (1968)] 176, 1112 (1968)

**Erratum: Current Algebra and Photoproduction of Pions**—M. S. Bhatia and P. Narayanaswamy. [172, 1742 (1968)] 176, 2167 (1968)

**Erratum: General Perturbation and Variational Methods for Responses to Time-Dependent Interactions in Quantum Mechanics**—Jean Heinrichs. [172, 1315 (1968)] 176, 2167 (1968)

**Erratum: Ionization Loss at Relativistic Velocities**—C. A. Nicoletta, P. J. McNulty, and P. L. Jain. [164, 1693 (1967)] 176, 2167 (1968)

**Erratum: Solutions of the Bethe-Salpeter and *N/D* Equations**—K. V. Vasavada. [165, 1830 (1968)] 176, 2167 (1968)

# Cumulative Author Index to Volumes 171–176

In this cumulative index complete paper citations are given under the name of each participating author, eliminating "See" references. Papers are arranged in ascending order of volume and page numbers.


AACHEN
Photoproduction of Meson and Baryon Resonances at Energies up to 5.8 GeV—Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration. 175, 1669 (1968)

AARON, R.
Relativistic Three-Body Theory with Applications to $\pi$-$N$ Scattering—R. Aaron, R. D. Amado, and J. E. Young. 174, 2022 (1968)

ABARBANEL, Henry D. I.
Construction of Local Quantum Fields Describing Many Masses and Spins—Henry D. I. Abarbanel and Y. Frishman. 171, 1442 (1968)

ABASHIAN, A.
Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)

ABBE, W. J.
Analytic Continuation of an Amplitude—W. J. Abbe and G. A. Gary. 174, 2015 (1968)

ABRAHAM, D. B.
Excitation Spectrum of Antiferromagnetic Rings—D. B. Abraham. 171, 572 (1968)

ABRAHAM, M. M.
Production of Divalent Thulium in CaO and $SrCl_2$—M. M. Abraham, R. W. Reynolds, and L. A. Boatner. 175, 485 (1968)

ABRAHAMS, S. C.
Atomic Displacement Relationship to Curie Temperature and Spontaneous Polarization in Displacive Ferroelectrics—S. C. Abrahams, S. K. Kurtz, and P. B. Jamieson. 172, 551 (1968)

ABRAMS, G. S.
Final States with Two or More Strange Particles from 4.25-BeV/$c$ $K^- p$ Interactions—G. S. Abrams, R. G. Glasser, B. Kehoe, B. Sechi-Zorn, and G. Wolsky. 175, 1697 (1968)

ABRAMS, R. J.
Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)

ADAIR, Robert K.
Diffraction-Disassociation Model of Very-High-Energy Nucleon-Nucleon Interactions and the Diffusion of Cosmic Rays through the Atmosphere—Robert K. Adair. 172, 1370 (1968)

ADAMS, J. L.
Neutron Spectroscopic Factors from Isobaric Analog States—W. J. Thompson, J. L. Adams, and D. Robson. 173, 975 (1968)

ADEMOLLO, M.
Bootstrap of Meson Trajectories from Superconvergence—M. Ademollo, H. R. Rubinstein, G. Veneziano, and M. A. Virasoro. 176, 1904 (1968)

ADLER, Ronald J.
Erratum: Threshold Electrodisintegration of the Deuteron—Ronald J. Adler. [169, 1192 (1968)] 174, 2169 (1968)

ADLER, Stephen L.
Erratum: Sum Rules for the Axial-Vector Coupling Constant Renormalization in $\beta$ Decay—Stephen L. Adler. [140, B736 (1965); 149, 1294(E) (1966)], 175, 2224 (1968)

ADLOFF, J. C.
Gamma Decays from the First $T=\frac{1}{2}$ Levels in $^{13}$N and $^{13}$C—C. L. Cocke, J. C. Adloff, and P. Chevallier. 176, 1120 (1968)

AFNAN, I. R.
Investigation of Nuclear Three- and Four-Body Systems with Soft-Core Nucleon-Nucleon Potentials—I. R. Afnan and Y. C. Tang. 175, 1337 (1968)
Comparison of Variational Results and Solutions of Faddeev Equation for a Local Potential—I. R. Afnan and Y. C. Tang. 176, 1232 (1968)

AGARWAL, B. K.
Rescattering Model Applied to $Y^*$ Production—C. P. Singh and B. K. Agarwal. 173, 1611 (1968)
Sum Rules for Meson-Baryon Scattering from Asymptotic Symmetry Requirements—V. P. Seth, B. K. Agarwal, and Y. M. Gupta. 173, 1759 (1968)

AGRAWAL, Ashok K.
Rotational Correlation Functions in Neutron Scattering by Molecular Gases—Ashok K. Agrawal and Sidney Yip. 171, 263 (1968)

AGUDÍN, Jorge
Time Delay of Scattering Processes—Jorge L. Agudín. 171 1385 (1968)

AHLERS, Guenter
Effect of the Gravitational Field on the Superfluid Transition in $He^4$—Guenter Ahlers. 171, 275 (1968)

AHMADZADEH, Akbar
Possible Classification of Exchange-Degenerate Trajectories—Akbar Ahmadzadeh and Richard J. Jacob. 176, 1719 (1968)

AITCHISON, I. J. R.
Watson's Theorem When There Are Three Strongly Interacting Particles in the Final State—I. J. R. Aitchison and C. Kacser. 173, 1700 (1968)

AKIBA, Tomoya
Spectral-Function Sum Rules with Symmetry Breaking—Tomoya Akiba and Kyungsik Kang. 172, 1551 (1968)

ALBERI, J. L.
Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)

ALBRIGHT, J. R.
$\pi^- p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)

ALBRITTON, D. L.
Mobilities of Mass-Identified $H_3^+$ and $H^+$ Ions in Hydrogen—D. L. Albritton, T. M. Miller, D. W. Martin, and E. W. McDaniel. 171, 94 (1968)

ALBURGER, D. E.
Gamma-Ray Decay of the 6.92-, 7.12-, 8.88-, and 13.10-MeV States in $O^{16}$—D. H. Wilkinson, D. E. Alburger, and J. Lowe. 173, 995 (1968)
Beta Decay of $N^{16}$ to the 6.05-MeV State of $O^{16}$—E. K. Warburton, W. R. Harris, and D. E. Alburger. 175, 1275 (1968)

ALDERSON, J. E. A.
Hall Coefficients of Cu, Ag, and Au in the Range 4.2–300°K—J. E. A. Alderson, T. Farrell, and C. M. Hurd. 174, 729 (1968)
Anisotropic Relaxation Times and the Hall Coefficients of α-Phase Alloys of the IB Metals—R. D. Barnard, J. E. A. Alderson, T. Farrell, and C. M. Hurd. 176, 761 (1968)

ALDRIDGE, J. P.
Optical-Model Analysis of Alpha-Particle Scattering by $^{40}Ca$ from 12 to 18 MeV—C. P. Robinson, J. P. Aldridge, Joseph John, and R. H. Davis. 171, 1241 (1968)

ALESSANDRINI, V. A.
Parity Doubling for Bosons and $M=1$ Propagators—V. A. Alessandrini. 172, 1503 (1968)

ALEXANDER, E. C.
Xenon-134 from the Decay of Cesium-134—E. C. Alexander, Jr., G. A. Bennett, B. Srinivasan, and O. K. Manuel. 175, 1494 (1968)

ALEXANDER, G.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer. J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)
Study of the Λ-$N$ System in Low-Energy Λ-$p$ Elastic Scattering—G. Alexander, U. Karshon, A. Shapira, G. Yekutieli, R. Engelmann, H. Filthuth, and W. Lughofer. 173, 1452 (1968)

ALEXANDER, Michael N.
Nuclear-Magnetic-Resonance Study of Heavily Nitrogen-Doped Silicon Carbide—Michael N. Alexander. 172, 331 (1968)

ALI, S.
Analysis of the ΛΛ Hypernucleus $_{\Lambda\Lambda}C^{14}$—S. Ali, L. P. Kok, and M. E. Grypeos. 171, 1203 (1968)

ALLEN, J. S.
$^{16}O(\alpha,2\alpha)^{12}C_{g.s.}$ Reaction Mechanisms near 25 MeV—A. W. Parker, J. S. Allen, R. L. Yerke, and V. G. Stotland. 174, 1093 (1968)

ALLEN, Kenneth R.
Lattice Thermal Conductivity for a One-Dimensional, Harmonic, Isotopically Disordered Crystal—Kenneth R. Allen and Joseph Ford. 176, 1046 (1968)

ALMEIDA, S. P.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)

ALVÄGER, Torsten
Quest for Faster-Than-Light Particles—Torsten Alvăger and Michael N. Kreisler. 171, 1357 (1968)

ALZETTA, R.
One-Neutron Transfer Reactions in Even and Odd Tin Isotopes and a Realistic Nucleon-Nucleon Potential—R. Alzetta and J. Sawicki. 173, 1185 (1968)

AMADO, R. D.
Relativistic Three-Body Theory with Applications to $\pi$-$N$ Scattering—R. Aaron, R. D. Amado, and J. E. Young. 174, 2022 (1968)

AMATYA, A. M. S.
Model for Pion $S$-Wave Phase Shifts from Current Algebra and Partial Conservation of Axial-Vector Current—A. M. S. Amatya, A. Pagnamenta, and B. Renner. 172, 1755 (1968)

AMIT, D. J.
Coupling of Density and Spin Fluctuations to Quasiparticles in a Fermi Liquid—D. J. Amit, J. W. Kane, and H. Wagner. 175, 313 (1968)
Logarithmic Terms in the Specific Heat of a Normal Fermi Liquid—D. J. Amit, J. W. Kane, and H. Wagner. 175, 326 (1968)

AMME, Robert C.
Vibrational Excitation Effects on Charge-Transfer Processes Involving $H_2^+$ and $D_2^+$ Between 70 and 1000 eV—Howard C. Hayden and Robert C. Amme. 172, 104 (1968)

AMOS, T. M.
Energy-Loss Straggling of Protons in Silicon—J. J. Kolata, T. M. Amos, and Hans Bichsel. 176, 484 (1968)

AMSTUTZ, Larry I.
Observation of Pair Interaction between Ortho Molecules in Solid $H_2$—A. Brooks Harris, Larry I. Amstutz, Horst Meyer, and Samuel M. Myers. 175, 603 (1968)

ANAND, J. D.
Rescattering Effects in the Quark Model for Meson-Baryon Couplings—J. D. Anand, V. S. Bhasin, and A. N. Mitra. 176, 1891 (1968)

ANDERSEN, H. H.
Stopping Power of the Elements $Z=20$ Through $Z=30$ for 5–12-MeV Protons and Deuterons—H. H. Andersen, C. C. Hanke, H. Simonsen, H. Sørensen, and P. Vajda. 175, 389 (1968)

ANDERSON, Elmer E.
Calculation of the Sublattice Magnetization of Yttrium Iron Garnet by the Oguchi Method—Denis F. Strenzwilk and Elmer E. Anderson. 175, 654 (1968)

ANDERSON, L. W.
Charge-Exchange Collisions Between Helium Ions and Cesium Vapor in the Energy Range 1.5–25 keV—A. S. Schlachter, D. H. Loyd, P. J. Bjorkholm, L. W. Anderson, and W. Haeberli. 174, 201 (1968)

ANDERSON, Stuart D.
Effect of the Existence of an Elementary Quark on High-Energy Scattering—Stuart D. Anderson. 176, 1881 (1968)

ANDERSON, V. E.
Ground-State Energy Eigenvalues and Eigenfunctions for an Electron in an Electric-Dipole Field—J. E. Turner, V. E. Anderson, and Kenneth Fox. 174, 81 (1968)

ANDERSON, W T., Jr.
Nuclear Magnetic Resonance in Dilute Alloys of Indium-Lead and Indium-Tin—W. T. Anderson, Jr., F. C. Thatcher, and R. R. Hewitt. 171, 541 (1968)

ANDREWS, J. M., Jr.
Effect of Phonon Dispersion on Heat-Pulse Shape—J. M. Andrews, Jr., and M. W. P. Strandberg. 172, 869 (1968)

ANTONIOU, N. G.
Lorentz-Pole Model and Polarization in High-Energy Charge-Exchange Pion-Nucleon Scattering—N. G. Antoniou, S. R. Komy, C. D. Palev, and M. Samiullah. 175, 1757 (1968)

APPEL, J. A.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)

Search for the Electroproduction of the $N^*(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)

ARBAB, Farzam

A Sum Rule Based on Unitarity—Farzam Arbab and Richard C. Slansky. 171, 1785 (1968)

Regge-Pole Model with the $M = 1$ Pion in $\pi^+p \to \rho^0\Delta^{++}$ and $\pi^+p \to \rho^+p$ Scattering—Farzam Arbab and Richard C. Brower. 175, 1991 (1968)

Factorization, Kinematic Singularities, and Conspiracies—Farzam Arbab and J. D. Jackson. 176, 1796 (1968)

ARENHÖVEL, Hartmuth

General Formulas for Describing the Absorption of Polarized Photons by Oriented Nuclei—Hartmuth Arenhövel. 171, 1212 (1968)

ARGYLE, B. E.

Magnetoelastic Behavior of Europium Oxide. II. Magnetostriction and the $\lambda$ Anomaly—B. E. Argyle and N. Miyata. 171, 555 (1968)

ARGYRES, Ernestos N.

Calculation of the $P_{11}$ $\pi N$ Phase Shift Using Coupled $\pi N$, $\sigma N$, and $\epsilon N$ Channels—Ernestos N. Argyres and Aaron Rotstein. 174, 1689 (1968)

ARKO, A. J.

High-Field Galvanomagnetic Effects in Antiferromagnetic Chromium—A. J. Arko, J. A. Marcus, and W. A. Reed. 176, 671 (1968)

ARMANI, Roland J.

Spontaneous-Fission Decay Constant of $^{238}$U—J. H. Roberts, Raymond Gold, and Roland J. Armani. 174, 1482 (1968)

ARMSTEAD, Robert L.

Electron-Hydrogen Scattering Calculation—Robert L. Armstead. 171, 91 (1968)

ARMSTRONG, J. C.

Elastic Scattering of 1- to 2.7-MeV Protons by $C^{14}$—W. R. Harris and J. C. Armstrong. 171, 1230 (1968)

ARMSTRONG, Lloyd, Jr.

Matrix Elements Between Configurations Having Several Open Shells. I—Lloyd Armstrong Jr. 172, 12 (1968)

Matrix Elements Between Configurations Having Several Open Shells. II—Lloyd Armstrong Jr. 172, 18 (1968)

Magnetic Interactions in Mixed Configurations—Lloyd Armstrong, Jr. and S. Feneuille. 173, 58 (1968)

ARMSTRONG, R. L.

Nuclear-Quadrupole-Resonance Study of Lattice Dynamics in $K_2PtCl_6$—K. R. Jeffrey and R. L. Armstrong. 174, 359 (1968)

ARNDT, Richard A.

Determination of the Nucleon-Nucleon Scattering Matrix. IX. $(\pi,p)$ Analysis from 7 to 750 MeV—Malcolm H. MacGregor, Richard A. Arndt, and Robert M. Wright. 173, 1272 (1968)

ARNOLD, Richard C.

Regge-Pole Eikonal Theory of Small-Angle Pion-Nucleon Scattering—Richard C. Arnold and Maurice L. Blackmon. 176, 2082 (1968)

ARNOWITT, R.

Hard-Pion Current-Algebra Calculation of Meson Processes—Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 1999 (1968)

Application of Hard-Pion Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 2008 (1968)

Hard-Pion Current-Algebra Calculation of Meson Processes—$N$-Point Functions—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1802 (1968)

Application of Hard-Pion Four-Point Functions to Pion-Pion Scattering—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1820 (1968)

ARONS, M. E.

Lorentz Invariance, Local Field Theory, and Faster-than-Light Particles—M. E. Arons and E. C. G. Sudarshan. 173, 1622 (1968)

Prediction for the Reaction $\pi N \to \pi N^*$ Based on a Partially Conserved Axial-Vector Current—M. E. Arons. 175, 1905 (1968)

ARONSON, S. H.

Experimental Study of the Decay $K_L^0 \to \pi + e + \nu$—S. H. Aronson and K. Wendell Chen. 175, 1708 (1968)

ARTHURS, A. M.

Upper and Lower Bounds on Scattering Lengths for Static Potentials—A. M. Arthurs. 176, 1730 (1968)

ARTMAN, J. O.

Determination of the Nuclear Quadrupole Moment of $Fe^{57m}$ from $\alpha$-$Fe_2O_3$ Data—J. O. Artman, A. H. Muir, Jr., and H. Wiedersich. 173, 337 (1968)

ASAWA, C. K.

Raman Spectrum of $LaBr_3$—C. K. Asawa. 173, 869 (1968)

ASCARELLI, P.

Velocity of Sound and Compressibility in Liquid Metals—P. Ascarelli. 173, 271 (1968)

ASCOLI, G.

Strange-Particle Production in 8-BeV/$c$ Proton-Proton Interactions—M. Firebaugh, G. Ascoli, E. L. Goldwasser, R. D. Sard, and J. Wray. 172, 1354 (1968)

ASCUITTO, R. J.

Collective Effects in the $P^{31}(He^3, p)S^{33}$ Reaction—R. S. Cox, R. W. West, and R. J. Ascuitto. 175, 1419 (1968)

Symmetric-Core Collective Model for Odd-Odd Nuclei with Applications in the $2s$-$1d$ Shell—R. J. Ascuitto, D. A. Bell, and J. P. Davidson. 176, 1323 (1968)

ASHCROFT, N. W.

Fermi Surface and Electronic Structure of Indium—N. W. Ashcroft and W. E. Lawrence. 175, 938 (1968)

ASHLEY, J. C.

Quantum Treatment of Multiple Real Transitions—J. C. Ashley and R. H. Ritchie. 174, 1572 (1968)

ASLANIDES, E.

Positron Decays of $^{31}$Ca and $^{38}$K—R. W. Kavanagh, A. Gallmann, E. Aslanides, F. Jundt, and E. Jacobs. 175, 1426 (1968)

ASPNES, D. E.

Electro-Optic Measurements of PbS, PbSe, and PbTe—D. E. Aspnes and M. Cardona. 173, 714 (1968)

ATKINSON, D.

Approximate Bounds on Coupling Constants from Analyticity, Crossing, and Unitarity—D. Atkinson and F. Calogero. 171, 1767 (1968)

Erratum: Construction of Solutions to Superconvergence Relations—D. Atkinson and M. B. Halpern. [166, 1724 (1968)] 171, 1834 (1968)

ATTI, C. Ciofi Degli

Short-Range Dynamical Correlations in $^6$Li from Electron Elastic Scattering—C. Ciofi Degli Atti. 175, 1256 (1968)

AUERBACH, E. H.

Optical-Model Analysis of Pion-Nucleus Scattering. II. Pion Form Factor—E. H. Auerbach, D. M. Fleming, and M. M. Sternheim. 171, 1781 (1968)

AUGUSTSON, R. H.

Fast-Photoneutron Spectra due to 55–85-MeV Photons—N. N. Kaushal, E. J. Winhold, P. F. Yergin, H. A. Medicus, and R. H. Augustson. 175, 1330 (1968)

AUSTIN, D. M.
Polarization in $\pi^- p \to \eta n$, the Double-Pole $A_2$, and a Possible Pion Conspirator—D. M. Austin, J. V. Beaupre, and K. E. Lassila. 173, 1573 (1968)

AUSTIN, S. M.
$^6$Li$(p,p')^6$Li(3.56 MeV) Reaction from $E_p$=24.3 to 46.4 MeV and the Effective Interaction—S. M. Austin, P. J. Locard, W. Benenson, and G. M. Crawley. 176, 1227 (1968)
Scattering of 24.5-MeV Protons from $^{89}$Y—W. Benenson, S. M. Austin, R. A. Paddock, and W. G. Love. 176, 1268 (1968)

AU-YANG, M. K.
Method of Calculating the Axial-Vector Current Coupling Constants for Lepton Decays of Baryons—M. K. Au-Yang. 174, 1731 (1968)

AU-YANG, M. Y.
Meson Captures in Solids—M. Y. Au-Yang and Marvin L. Cohen. 174, 468 (1968)

AXT, Carl J.
Temperature Dependence of the Flux-Flow Resistance near $H_{c2}$ in Type-II Superconductors—Carl J. Axt and W. C. H. Joiner. 171, 461 (1968)

BABU, P.
Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: General Features—P. Babu, S. Frautschi, and N. S. Thornber. 172, 1389 (1968)

BACH, Richard
$A^{-1/6}$ Dependence of Giant Dipole Energies—Richard Bach and Carl Werntz. 173, 958 (1968)

BADER, Todd R.
Polarization Dependence of Two-Photon Absorption in Solids—Todd R. Bader and Albert Gold. 171, 997 (1968)

BAIERLEIN, Ralph
Lunar Laser Ranging and the Brans-Dicke Theory—Christine Krogh and Ralph Baierlein. 175, 1576 (1968)

BAILEY, P. T.
Free-Carrier and Exciton Recombination Radiation in GaAs—M. A. Gilleo, P. T. Bailey, and D. E. Hill. 174, 898 (1968)

BAILYN, M.
Helium Drag in the Theory of Impurity Mobility in Liquid Helium—M. Bailyn and R. Lobo. 176, 222 (1968)

BAKER, M. P.
Measurements of the $^{63}$Cu$(\gamma,n)$ and $(\gamma,2n)$ Cross Sections—R. E. Sund, M. P. Baker, L. A. Kull, and R. B. Walton. 176, 1366 (1968)

BAKER, W. L.
Polarization of the Neutrons from the $^{12}$C$(d,n)^{13}$N Reaction at the 4-MeV Resonance and between 5.2 and 6.2 MeV—T. R. Donoghue, W. L. Baker, P. L. Beach, D. C. DeMartini, and C. R. Soltesz. 173, 952 (1968)

BAKHRU, H.
Deformation in the Light Ba Isotopes: Isomeric States of $Ba^{125}$ and $Ba^{127}$—J. M. D'Auria, H. Bakhru, and I. L. Preiss. 172, 1176 (1968)
Decay Studies of Iodine-118 and -120—Inge-Maria Ladenbauer-Bellis and H. Bakhru. 175, 1507 (1968)

BALACHANDRAN, A. P.
Simultaneous "Partial-Wave" Expansion in the Mandelstam Variables: Crossing Symmetry for Partial Waves—A. P. Balachandran and J. Nuyts. 172, 1821 (1968)
Eigenvectors for the Partial-Wave "Crossing Matrices"—A. P. Balachandran, W. J. Meggs, and P. Ramond. 175, 1974 (1968)
Simultaneous Partial-Wave Expansion in the Mandelstam Variables: The Group $SU(3)$—A. P. Balachandran, W. J. Meggs, J. Nuyts, and P. Ramond. 176, 1700 (1968)

BALÁZS, L. A. P
Two Simple Approximation Schemes for Lippmann-Schwinger-Type Equations—L. A. P. Balázs and Sharashchandra H. Patil. 171, 1633 (1968)
Equivalent-Potential Approach Using the Bethe-Salpeter and Unitarity Equations—Louis A. P. Balázs. 176, 1769 (1968)

BALKANSKI, M.
Raman Scattering in $KNO_3$ Phases I, II, and III—M. Balkanski, M. K. Teng, and M. Nusimovici. 176, 1098 (1968)

BALL, J. B.
Neutron Hole States in $Z$ = 40 Nuclei Studied with the $(p,d)$ Reaction on $^{90}$Zr, $^{91}$Zr, and $^{92}$Zr—J. B. Ball and C. B. Fulmer. 172, 1199 (1968)

BALL, James S.
Faddeev Equations for Atomic Problems and Solutions for the $(e, H)$ System—James S. Ball, Joseph C. Y. Chen, and David Y. Wong. 173, 202 (1968)

BALLANTYNE, J. M.
Temperature-Dependent Vibrational Modes in Sodium Nitrite—M. K. Barnoski and J. M. Ballantyne. 174, 946 (1968)

BALSLEV, Ivar
Optical Absorption due to Inter-Conduction-Minimum Transitions in Gallium Arsenide—Ivar Balslev. 173, 762 (1968)

BANDER, Myron
Analytic Properties of Current-Algebra Vertex Functions—Myron Bander. 173, 1568 (1968)
Asymptotic Sum Rules—Myron Bander and J. D. Bjorken. 174, 1704 (1968)

BANDYOPADHYAY, Pratul
Possible Weak Interaction of Photons and Emission of Neutrinos from Stars—Pratul Bandyopadhyay. 173, 1481 (1968)

BANERJEE, M. K.
Universal Coupling of the $\omega$ Meson and Regge Residues—M. K. Banerjee and C. A. Levinson. 176, 2140 (1968)

BARBER, W. C.
1-BeV Electron Compton Scattering near 180°—B. Gittelman, W. C. Barber, W. Selove, D. Tompkins, and F. Forman. 171, 1388 (1968)

BARBIELLINI, G.
Proton Compton Effect by Polarized Photons at 90° in the c.m. System in the First Resonance Region—G. Barbiellini, G. Capon, G. De Zorzi, and G. P. Murtas. 174, 1665 (1968)

BARDAKCI, K.
Canonical Representation of Sugawara's Theory—K. Bardakci and M. B. Halpern. 172, 1542 (1968)
Theories at Infinite Momentum—K. Bardakci and M. B. Halpern. 176, 1686 (1968)

BARDEEN, W. A.
Invariant Amplitudes for Photon Processes—W. A. Bardeen and Wu-Ki Tung. 173, 1423 (1968)

BARDWICK, John
Levels of $Bi^{200}$ Observed in the $Pb^{198}(He^3,d)$ Reaction—John Bardwick and Robert Tickle. 171, 1305 (1968)

BARHAM, D. C.
Nuclear Magnetic Resonance in the Metal $ReO_3$: $^{185}$Re and $^{187}$Re Knight Shifts and Spin Relaxation Rates—Albert Narath and D. C. Barham. 176, 479 (1968)

BARKER, A. A.
Monte Carlo Study of a Hydrogenous Plasma near the Ionization Temperature—A. A. Barker. 171, 186 (1968)

BARKER, A. S., Jr.
Optical Properties of $VO_2$ between 0.25 and 5 eV—Hans W. Verleur, A. S. Barker, Jr., and C. N. Berglund. 172, 788 (1968)

Long-Wavelength Optical Lattice Vibrations in Mixed $KMgF_3$-$KNiF_3$ Crystals—A. S. Barker, Jr., J. A. Ditzenberger, and H. J. Guggenheim. 175, 1180 (1968)

BARMATZ, M.

Measurement of the Density Maximum of $He^4$ at Saturated Vapor Pressure—M. Barmatz and I. Rudnick. 173, 275 (1968)

BARNA, A.

Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)

BARNARD, R. D.

Anisotropic Relaxation Times and the Hall Coefficients of α-Phase Alloys of the IB Metals—R. D. Barnard, J. E. A. Alderson, T. Farrell, and C. M. Hurd. 176, 761 (1968)

BARNES, Robert F.

Multiphonon Scattering of Low-Energy Electrons—Robert F. Barnes, Max G. Lagally, and Maurice B. Webb. 171, 627 (1968)

BARNOSKI, M. K.

Temperature-Dependent Vibrational Modes in Sodium Nitrite—M. K. Barnoski and J. M. Ballantyne. 174, 946 (1968)

BARON, N.

Core Excitations in $^{107}Ag$, $^{109}Ag$, $^{113}In$, $^{115}In$, $^{121}Sb$, and $^{123}Sb$ Resulting from Inelastic Scattering of 42-MeV Alpha Particles—W. M. Stewart, N. Baron, and R. F. Leonard. 171, 1316 (1968)

BARRY, Jeremiah H.

Statistical-Mechanical Theory of Resonance Susceptibility in Heisenberg Antiferromagnetism—Jeremiah H. Barry. 174, 531 (1968)

BARSCH, G. R.

Pressure Derivatives of Second-Order Elastic Constants of MgO—S. Y. La and G. R. Barsch. 172, 957 (1968)

BARSHAY, Saul

Emission of Low-Energy Photons in Scattering and Decay Processes and a Possible Method for Determining Electromagnetic Properties of Short-Lived States—Saul Barshay and Tsu Yao. 171, 1708 (1968)

BARTOLINI, W.

Measurement of the Coherent Neutron Scattering Amplitude of Deuterium, Mercury, and Fluorine by Mirror Reflection—W. Bartolini, R. E. Donaldson, and D. J. Groves. 174, 313 (1968)

BARTRAM, Ralph H.

Stopping Power and Luminescent-Response Calculation for Channeling in NaI(Tl) and CsI(Tl)—Myron Luntz and Ralph H. Bartram. 175, 468 (1968)

Ion-Size Effects in Color Centers—R. H. Bartram, A. M. Stoneham, and Philip Gash. 176, 1014 (1968)

BARUT, A. O.

High-Energy Proton-Proton Scattering and Nucleon Structure: The Scalar Interaction in $O(4,2)$—A. O. Barut and Dennis Corrigan. 172, 1593 (1968)

BASHARA, N. M.

Electroreflectance Changes in Dielectric Constants of Au and Ag by Modulated Ellipsometry—A. B. Buckman and N. M. Bashara. 174, 719 (1968)

BASS, Isaac L.

Electron-Nuclear Double-Resonance Study of the Self-Trapped Hole Associated with Lithium in NaF—Isaac L. Bass and Robert Lee Mieher. 175, 421 (1968)

BASSEL, Robert H.

High-Energy Proton Scattering and the Structure of Light Nuclei—Robert H. Bassel and Colin Wilkin. 174, 1179 (1968)

BASU, Debabrata

Current Algebra and $K^+\Lambda$ Photoproduction—Debabrata Basu and R. N. Chaudhuri. 175, 2075 (1968)

Complex $\bar{K}N$ Scattering Lengths and Current Algebra—Debabrata Basu, S. N. Biswas, and K. Datta. 176, 1835 (1968)

BATCHELDER, D. N.

Isotope Effects in the Lattice Constant and Thermal Expansion of $^{20}Ne$ and $^{22}Ne$ Single Crystals—D. N. Batchelder, D. L. Losee, and R. O. Simmons. 173, 873 (1968)

BATON, J. P.

$\pi^- p \to \pi^- \pi^0 p$ Reaction at 2.77 GeV/$c$ for Low Momentum Transfers to the Proton—J. P. Baton and G. Laurens. 176, 1574 (1968)

BATTLESON, K.

Lifetimes, Energies, and Branching Ratios of $^{28}Si$ Excited States—E. F. Gibson, K. Battleson, and D. K. McDaniels. 172, 1004 (1968)

BAUMAN, R. P.

Optical Phonons of Yttrium Aluminum Garnet—J. P. Hurrell, S. P. S. Porto, I. F. Chang, S. S. Mitra, and R. P. Bauman. 173, 851 (1968)

Raman Spectrum of Single-Domain $BaTiO_3$—M. DiDomenico, Jr., S. H. Wemple, S. P. S. Porto, and R. P. Bauman. 174, 522 (1968)

BAUMGARDNER, Carl A.

Effects of Current Flow on the Optical Absorption of a Semiconductor—Carl A. Baumgardner and Truman O. Woodruff. 173, 746 (1968)

BAYM, Gordon

Phonon-Quasiparticle Interactions in Dilute Solutions of $He^3$ in Superfluid $He^4$. II. Phonon Boltzmann Equation and First Viscosity—Gordon Baym and W. F. Saam. 171, 172 (1968)

Phonon-Quasiparticle Interactions in Dilute Solutions of $He^3$ in Superfluid $He^4$: III. Attenuation of First Sound Above 0.2°K—Gordon Baym, W. F. Saam, and C. Ebner. 173, 306 (1968)

BAYMAN, B. F.

Analysis of Two-Neutron ($L = 0$) Transfer Cross Sections for Calcium and Nickel—B. F. Bayman and Norton M. Hintz. 172, 1113 (1968)

BEACH, P. L.

Polarization of the Neutrons from the $^{12}C(d,n)^{13}N$ Reaction at the 4-MeV Resonance and between 5.2 and 6.2 MeV—T. R. Donoghue, W. L. Baker, P. L. Beach, D. C. DeMartini, and C. R. Soltesz. 173, 952 (1968)

BÉAL-MONOD, M. T.

Spin Waves in $He^3$ in the Paramagnon Model—Shang-keng Ma, M. T. Béal-Monod, and Donald R. Fredkin. 174, 227 (1968)

BEARSE, R. C.

Gamma Decay of $T = \frac{1}{2}$ States in $Al^{25}$ and $P^{29}$—G. C. Morrison, D. H. Youngblood, R. C. Bearse, and R. E. Segel. 174, 1366 (1968)

Study of the $Na^{23}(He^3, d)Mg^{24}$ Reaction—R. C. Bearse and J. L. Yntema. 175, 1442 (1968)

BEATTIE, A. G.

Magnetoacoustic Dispersion and Attenuation; Comparison of Experiment with the Free-Electron Theory—A. G. Beattie. 174, 721 (1968)

Ultrasonic Determination of the Pressure Dependence of the Superconducting Energy Gap in Tin—A. G. Beattie, J. E. Schirber, and J. R. Neighbours. 175, 599 (1968)

BEAUPRE, J. V.

Polarization in $\pi^- p \to \eta n$, the Double-Pole $A_2$, and a Possible Pion Conspirator—D. M. Austin, J. V. Beaupre, and K. E. Lassila. 173, 1573 (1968)

BEBB, H. Barry
Bound-Exciton, Free-Exciton, Band-Acceptor, Donor-Acceptor, and Auger Recombination in GaAs—E. Hal Bogardus and H. Barry Bebb. 176, 993 (1968)

BECKER, J. A.
$Ne^{22}(t,p\gamma)Ne^{24}$ Angular Correlation Study—J. A. Becker, L. F. Chase, Jr., R. E. McDonald, and E. K. Warburton. 176, 1310 (1968)

BECKER, M. S.
A Parametric Approach to the Ground-State Energy of an Electron Gas—M. S. Becker, A. A. Broyles, and Tucson Dunn. 175, 224 (1968)

BECKER, Richard L.
Brueckner Theory in an Oscillator Basis. I. The Method of Reference Bethe-Goldstone Equations and Comparison of the Yale, Reid (Hard-Core), and Hamada-Johnston Interactions—Richard L. Becker, Alan D. MacKellar, and B. M. Morris. 174, 1264 (1968)

BEDERSON, Benjamin
Measurement of the Electric Dipole Polarizabilities of Metastable Mercury—Judah Levine, Robert J. Celotta, and Benjamin Bederson. 171, 31 (1968)

BEER, M.
$Au^{197}(n,\gamma)Au^{198}$ Reaction Mechanism—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 173, 1170 (1968)

Resonant and Nonresonant Capture of Slow Neutrons in $Tm^{169}(n,\gamma)Tm^{170}$—M. A. Lone, R. E. Chrien, O. A. Wasson, M. Beer, M. R. Bhat, and H. R. Muether. 174, 1512 (1968)

Direct Neutron Capture in $Co^{59}(n,\gamma)Co^{60}$—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 176, 1314 (1968)

BEERY, D. B.
High-Resolution Gamma-Ray Spectroscopic Studies of the Decays of 2.6-h $Nd^{141g}$ and 60-sec $Nd^{141m}$—D. B. Beery, W. H. Kelly, and Wm. C. McHarris. 171, 1283 (1968)

BEEZHOLD, Wendland
Determination of the Electric-Field-Gradient Tensor at the Arsenic Site in $KH_2AsO_4$ by Proton Relaxation Measurements—Wendland Beezhold and Edwin A. Uehling. 175, 624 (1968)

BÉG, M. A. B.
Field-Current Identities and Nucleon Radii—M. A. B. Bég, J. Bernstein, and M. Tausner. 173, 1523 (1968)

BEHKAMI, A. N.
Structure of the Fission Transition Nucleus $U^{236}$—A. N. Behkami, J. H. Roberts, W. Loveland, and J. R. Huizenga. 171, 1267 (1968)

Nuclear Pairing Energy of Transition Nucleus $Pu^{240}$—J. R. Huizenga, A. N. Behkami, J. W. Meadows, Jr., and E. D. Klema. 174, 1539 (1968)

BEHRENS, M.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)

BELL, D. A.
Symmetric-Core Collective Model for Odd-Odd Nuclei with Applications in the 2$s$-1$d$ Shell—R. J. Ascuitto, D. A. Bell, and J. P. Davidson. 176, 1323 (1968)

BELLAMY, E. H.
Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)

BELTRÁN-LÓPEZ, V.
Calculation of the Magnetic Moment of Atomic Fluorine—V. Beltrán-López, E. Ley Koo, N. Segovia, and E. Blaisten. 172, 44 (1968)

BENAKSAS, D.
Charged Component of 1-GeV Electron Showers in Lead—D. J. Drickey, J. R. Kilner, and D. Benaksas. 171, 310 (1968)

BENDEL, W. L.
Inelastic Electron Scattering from $^{24}Mg$ at 180°—L. W. Fagg, W. L. Bendel, R. A. Tobin, and H. F. Kaiser. 171, 1250 (1968)

Inelastic Electron Scattering from $^{26}Mg$ at 180°.—W. L. Bendel, L. W. Fagg, R. A. Tobin, and H. F. Kaiser. 173, 1103 (1968)

BENDER, C. F.
Application of Geminal Methods to Molecular Calculations—C. F. Bender, E. R. Davidson, and F. D. Peat. 174, 75 (1968)

BENENSON, W.
$^6Li(p,p')^6Li(3.56\ MeV)$ Reaction from $E_p$=24.3 to 46.4 MeV and the Effective Interaction—S. M. Austin, P. J. Locard, W. Benenson, and G. M. Crawley. 176, 1227 (1968)

Scattering of 24.5-MeV Protons from $^{89}Y$—W. Benenson, S. M. Austin, R. A. Paddock, and W. G. Love. 176, 1268 (1968)

BENESCH, W.
Evidence for the $^3\Delta_u$–$B^3\Pi_g$ Transition in $N_2$—H. L. Wu and W. Benesch. 172, 31 (1968)

Erratum: Evidence for the $^3\Delta_u$–$B^3\Pi_g$ Transition in $N_2$—H. L. Wu and W. Benesch. [172, 31 (1968)] 176, 423 (1968)

BENNEMANN, K. H.
Anomalous Thermal Conductivity of Superconductors due to Impurity Spin Ordering—K. H. Bennemann and F. M. Mueller. 176, 546 (1968)

BENNETT, Alan J.
Theory of the Tunneling Spectroscopy of Collective Excitations—Alan J. Bennett, C. B. Duke, and S. D. Silverstein. 176, 969 (1968)

BENNETT, G. A.
Xenon-134 from the Decay of Cesium-134—E. C. Alexander, Jr., G. A. Bennett, B. Srinivasan, and O. K. Manuel. 175, 1494 (1968)

BENNETT, Herbert S.
Diffuse and Propagating Modes in the Heisenberg Paramagnet—Herbert S. Bennett. 174, 629 (1968)

Phenomenology of Neutron Scattering in Heisenberg Systems—Herbert S. Bennett. 176, 650 (1968)

BENNETT, Lawrence H.
Solute Knight Shifts in Noble Metals—Lawrence H. Bennett, R. W. Mebs, and R. E. Watson. 171, 611 (1968)

BENT, M.
Nuclear Properties and Magnetic Hyperfine Interaction of $Os^{189}$—B. Persson, H. Blumberg, and M. Bent. 174, 1509 (1968)

BENVENISTE, J.
Influence of Angular Momentum on the Decay of the $Ni^{60}$ Compound Nucleus—J. Benveniste, G. Merkel, and A. Mitchell. 174, 1357 (1968)

BERENDS, F. A.
Theoretical Study of $K_{l4}$ Decay—F. A. Berends, A. Donnachie, and G. C. Oades. 171, 1457 (1968)

BERETVAS, A.
Measurements of $C_{NN}$ in Proton-Proton Scattering from 305 to 415 MeV—A. Beretvas. 171, 1392 (1968)

BERGLUND, C. N.
Optical Properties of $VO_2$ between 0.25 and 5 eV—Hans W. Verleur, A. S. Barker, Jr., and C. N. Berglund. 172, 788 (1968)

BERGMANN, Ernest E.
Tests for $|\Delta I|\leq 1$ in Electromagnetic Interactions—Ernest E. Bergmann. 172, 1441 (1968)
BERGWALL, Staffan
Experimental Evidence for the Parratt X-Ray Excitation Theory—Staffan Bergwall and Arun S. Nigavekar. 175, 33 (1968)
BERICK, A. C.
Elastic Scattering of 14-MeV Neutrons by Deuterons—A. C. Berick, R. A. J. Riddle, and C. M. York. 174, 1105 (1968)
BERKEY, G. B.
Antiprotons and Positrons in Cosmic Rays—C. S. Shen and G. B. Berkey. 171, 1344 (1968)
BERLIN
Photoproduction of Meson and Baryon Resonances at Energies up to 5.8 GeV—Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration. 175, 1669 (1968)
BERLINGER, W.
Paramagnetic Resonance of $Cr^{3+}$ in the Layer Structure of $NaInS_2$—K. A. Müller and W. Berlinger. 175, 503 (1968)
BERNSTEIN, E. M.
$^{13}N$ Levels from $^{12}C(p,p)^{12}C$—E. M. Bernstein and G. E. Terrell. 173, 937 (1968)
Polarization in $^{12}C(p,p)^{12}C$—G. E. Terrell, M. F. Jahns, M. R. Kostoff, and E. M. Bernstein. 173, 931 (1968)
BERNSTEIN, J.
Field-Current Identities and Nucleon Radii—M. A. B. Bég, J. Bernstein, and M. Tausner. 173, 1523 (1968)
BERREMAN, Dwight W.
Adjusting Poles and Zeros of Dielectric Dispersion to Fit Reststrahlen of $PrCl_3$ and $LaCl_3$—Dwight W. Berreman and Frank C. Unterwald. 174, 791 (1968)
BERRY, R. Stephen
Angular Distribution of Molecular Photoelectrons—John C. Tully, R. Stephen Berry and Bryan J. Dalton. 176, 95 (1968)
BERSHADER, Daniel
Measurement of the Sodium *D*-Line Absolute Oscillator Strengths by the Roschdestvenskii Hook Method—Carl A. Forbrich, Jr., Wayland C. Marlow, and Daniel Bershader. 173, 150 (1968)
BERTHIER, Gaston
Correlation Coefficients for Electronic Wave Functions—Werner Kutzelnigg, Giuseppe Del Re, and Gaston Berthier. 172, 49 (1968)
BERTINI, Hugo W.
Comparison of Calculated Radiochemical Cross Sections with Experimental Results for Incident Protons and $\pi^-$ Mesons in the 50- to 400-MeV Region: Effect of Varying a Few Nuclear Parameters in the Calculations—Hugo W. Bertini. 171, 1261 (1968)
BERTSCH, George F.
State Dependence of Coulomb Interaction in Nuclei—George F. Bertsch. 174, 1313 (1968)
BESSON, J. M.
Tuning of PbSe Lasers by Hydrostatic Pressure from 8 to 22 $\mu$—J. M. Besson, William Paul, and A. R. Calawa. 173, 699 (1968)
BETOURNE, C.
Positive Pion Photoproduction from Hydrogen for Incident Photon Energies 300–750 MeV—C. Betourne, J. C. Bizot, J. Perez-Y-Jorba, D. Treille, and W. Schmidt. 172, 1343 (1968)
BETTERTON, J. O., Jr.
Specific Heat of Uranium Mononitride from 1.3 to 4.6°K—J. O. Scarbrough, H. L. Davis, W. Fulkerson, and J. O. Betterton, Jr. 176, 666 (1968)
BHADRA, D. K.
Effect of Toroidal Magnetic Field on Low-Frequency Plasma Instabilities in a Multipole Machine—D. K. Bhadra. 171, 188 (1968)
BHANDARI, C. M.
Erratum: Role of Longitudinal and Transverse Phonons in Lattice Thermal Conductivity of GaAs and InSb—C. M. Bhandari and G. S. Verma. [140, A2101 (1965)] 176, 1112 (1968)
BHARGAVA, S. C.
Current Algebra and Double-Pion Photoproduction—S. C. Bhargava. 174, 1969 (1968)
BHASIN, H. C.
Mössbauer Studies of the $SrTiO_3$:$Fe^{57}$ System—V. G. Bhide and H. C. Bhasin. 172, 290 (1968)
BHASIN, V. S.
Rescattering Effects in the Quark Model for Meson-Baryon Couplings—J. D. Anand, V. S. Bhasin, and A. N. Mitra. 176, 1891 (1968)
BHAT, M. R.
$Au^{197}(n,\gamma)Au^{198}$ Reaction Mechanism—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 173, 1170 (1968)
Resonant and Nonresonant Capture of Slow Neutrons in $Tm^{169}(n,\gamma)Tm^{170}$—M. A. Lone, R. E. Chrien, O. A. Wasson, M. Beer, M. R. Bhat, and H. R. Muether. 174, 1512 (1968)
Direct Neutron Capture in $Co^{59}(n,\gamma)Co^{60}$—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 176, 1314 (1968)
BHATIA, A. B.
Brillouin Scattering in Relaxing Liquids—A. B. Bhatia and E. Tong. 173, 231 (1968)
BHATIA, A. K.
Doubly Excited States of $H^-$ of High Principal Quantum Number: Implications for Electron-Atom Ionization—A. Temkin, A. K. Bhatia, and E. Sullivan. 176, 80 (1968)
BHATIA, M. S.
Current Algebra and Photoproduction of Pions—M. S. Bhatia and P. Narayanaswamy. 172, 1742 (1968)
Erratum: Current Algebra and Photoproduction of Pions—M. S. Bhatia and P. Narayanaswamy. [172, 1742 (1968)] 176, 2167 (1968)
BHIDE, V. G.
Mössbauer Studies of the $SrTiO_3$:$Fe^{57}$ System—V. G. Bhide and H. C. Bhasin. 172, 290 (1968)
Mössbauer Effect for $Fe^{57}$ in $Al_2O_3$—Effects of Variety of Heat Treatments—V. G. Bhide and S. K. Date. 172, 345 (1968)
BIALYNICKA-BIRULA, Z.
Properties of the Generalized Coherent State—Z. Bialynicka-Birula. 173, 1207 (1968)
BICHSEL, Hans
Mean Excitation Potential of Light Compounds—C. Tschalär and Hans Bichsel. 175, 476 (1968)
Energy-Loss Straggling of Protons in Silicon—J. J. Kolata, T. M. Amos, and Hans Bichsel. 176, 484 (1968)
BIENENSTOCK, Arthur
Ordering Energy and Effective Pairwise Interactions in a Binary Alloy of Simple Metals—Timothy M. Hayes, Harvey Brooks, and Arthur Bienenstock. 175, 699 (1968)
BILPUCH, E. G.
High-Resolution Study of Isobaric Analog Resonances in $^{23}Na$—G. A. Keyworth, P. Wilhjelm, G. C. Kyker, Jr., H. W. Newson, and E. G. Bilpuch. 176, 1302 (1968)
BIONDI, Manfred A.
Recombination, Attachment, and Ambipolar Diffusion of Electrons in Photo-Ionized NO Afterglows—Charles S. Weller and Manfred A. Biondi. 172, 198 (1968)
Temperature Dependence of the Electron - $O_2^+$-Ion Recombination Coefficient—W. H. Kasner and Manfred A. Biondi. 174, 139 (1968)

Electron-Temperature Dependence of Electron-Ion Recombination in Argon—F. J. Mehr and Manfred A. Biondi. 176, 322 (1968)

BIRGENEAU, R. J.
Magnetic Interactions between Rare-Earth Ions in Insulators. III. EPR Measurements of $Ce^{3+}$ Pair-Interaction Constants in $LaCl_3$—R. J. Birgeneau, M. T. Hutchings, and R. N. Rogers. 175, 1116 (1968)
Erratum: Magnetic Interactions between Rare-Earth Ions in Insulators. I. Accurate Electron-Paramagnetic-Resonance Determination of $Gd^{3+}$ Pair-Interaction Constants in $LaCl_3$—M. T. Hutchings, R. J. Birgeneau, and W. P. Wolf. [168, 1026 (1968)] 176, 1112 (1968)

BIS, R. F.
Band Inversion and the Electrical Properties of $Pb_xSn_{1-x}Te$—J. R. Dixon and R. F. Bis. 176, 942 (1968)

BISHARI, M.
Meson Bootstraps for Unnatural-Parity States—M. Bishari, H. R. Rubinstein, A. Schwimmer, and G. Veneziano. 176, 1926 (1968)

BISIACCHI, G.
Majorana Equations for Composite Systems—G. Bisiacchi, P. Budini, and G. Calucci. 172, 1508 (1968)

BISWAS, N. N.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

BISWAS, S. N.
Singularities of a Bethe-Salpeter Amplitude—H. S. Green and S. N. Biswas. 171, 1511 (1968)
Complex $\bar{K}N$ Scattering Lengths and Current Algebra—Debabrata Basu, S. N. Biswas, and K. Datta. 176, 1835 (1968)

BITAR, Khalil M.
Daughters, Conspiracies, and Lorentz Symmetry—Khalil M. Bitar and Graham L. Tindle. 175, 1835 (1968)

BIZOT, J. C.
Positive Pion Photoproduction from Hydrogen for Incident Photon Energies 300–750 MeV—C. Betourne, J. C. Bizot, J. Perez-Y-Jorba, D. Treille, and W. Schmidt. 172, 1343 (1968)

BJORKEN, J. D.
Renormalization of Weak Form Factors, and the Cabibbo Angle—H. R. Quinn and J. D. Bjorken. 171, 1660 (1968)
Asymptotic Sum Rules—Myron Bander and J. D. Bjorken. 174, 1704 (1968)

BJORKHOLM, P. J.
Charge-Exchange Collisions Between Helium Ions and Cesium Vapor in the Energy Range 1.5–25 keV—A. S. Schlachter, D. H. Loyd, P. J. Bjorkholm, L. W. Anderson, and W. Haeberli. 174, 201 (1968)

BLACKMON, Maurice L.
Regge-Pole Eikonal Theory of Small-Angle Pion-Nucleon Scattering—Richard C. Arnold and Maurice L. Blackmon. 176, 2092 (1968)

BLAESSER, G.
Theory of Localized Vibrations of Interstitial Atoms in bcc Lattices—G. Blaesser, J. Peretti, and G. Toth. 171, 665 (1968)

BLAISTEN, E.
Calculation of the Magnetic Moment of Atomic Fluorine—V. Beltrán-López, E. Ley Koo, N. Segovia, and E. Blaisten. 172, 44 (1968)

BLAKEMORE, J. S.
Photoconductivity Associated with Indium Acceptors in Silicon—J. S. Blakemore and C. E. Sarver. 173, 767 (1968)

BLANKENBECLER, R.
Feynman-Diagram Models of Regge-Pole Conspiracies—R. Blankenbecler, R. L. Sugar, and J. D. Sullivan. 172, 1451 (1968)
Variational Principles for Crossing-Symmetric Off-Shell Equations—Richard W. Haymaker and R. Blankenbecler. 171, 1581 (1968)
Stationary Expectation Values and Slopes of Daughter Regge Trajectories for the Bethe-Salpeter Equation—Rabinder N. Madan, Richard W. Haymaker, and R. Blankenbecler. 172, 1788 (1968)

BLANN, Marshall
Stopping Powers of $S^{32}$, $Cl^{35}$, $Br^{79}$, and $I^{127}$ Ions in Mylar—T. E. Pierce, W. W. Bowman, and Marshall Blann. 172, 287 (1968)
Stopping Powers and Ranges of 5–90-MeV $S^{32}$, $Cl^{35}$, $Br^{79}$, and $I^{127}$ Ions in $H_2$, He, $N_2$, Ar, and Kr: A Semiempirical Stopping Power Theory for Heavy Ions in Gases and Solids—T. E. Pierce and Marshall Blann. 173, 390 (1968)

BLATT, S. L.
Reaction $T(^3He,\gamma)^6Li$ in the Energy Range 0.5–11 MeV—S. L. Blatt, A. M. Young, S. C. Ling, K. J. Moon, and C. D. Porterfield. 176, 1147 (1968)

BLAZEY, K. W.
Antiferromagnetism and the Magnetic Phase Diagram of $GdAlO_3$—K. W. Blazey and H. Rohrer. 173, 574 (1968)

BLECHER, M.
Single-Proton Emission Following Positive Pion Absorption in Carbon—T. R. Witten, M. Blecher, and K. Gotow. 174, 1166 (1968)

BLEWER, R. S.
Lattice Thermal Conductivity, Nernst-Ettinghausen Effect, and Specific Heat in Antimony at Low Temperature—R. S. Blewer, N. H. Zebouni, and C. G. Grenier. 174, 700 (1968)

BLINC, R.
Nuclear-Magnetic-Resonance Study of the Ferroelectric Transitions in $NaH_3(SeO_3)_2$ and $NaD_3(SeO_3)_2$—R. Blinc, J. Stepišnik, and I. Zupančič. 176, 732 (1968)

BLOBEL, V.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)

BLOEMBERGEN, N.
Nonlinear Optical Susceptibilities in Group-IV and III-V Semiconductors—Sudhanshu S. Jha and N. Bloembergen. 171, 891 (1968)
Second-Harmonic Light Generation in Crystals with Natural Optical Activity—H. J. Simon and N. Bloembergen. 171, 1104 (1968)
Optical Second-Harmonic Generation in Reflection from Media with Inversion Symmetry—N. Bloembergen, R. K. Chang, S. S. Jha, and C. H. Lee. 174, 813 (1968)

BLOMQVIST, C.-E.
Optical Properties of Epitaxial PbSe Films—C.-E. Blomqvist and P.-O. Nilsson. 174, 849 (1968)

BLOOM, S. D.
$E2$ and $M1$ Matrix Elements in $B^{10}_4$—E. K. Warburton, J. W. Olness, S. D. Bloom, and A. R. Poletti. 171, 1178 (1968)

BLOOMFIELD, Philip E.
Size-Dependent Oscillatory Magnetoresistance Effect in Gallium—J. A. Munarin, J. A. Marcus, and Philip E. Bloomfield. 172, 718 (1968)
Optical Properties of Free-Electron-Like Foils—R. J. Esposito, Philip E. Bloomfield, and L. Muldawer. 176, 886 (1968)

BLUMBERG, H.
Nuclear Properties and Magnetic Hyperfine Interaction of $Os^{189}$—B. Persson, H. Blumberg, and M. Bent. 174, 1509 (1968)

BLUME, M.
Resonant Absorption in the Presence of Faraday Rotation—M. Blume and O. C. Kistner. 171, 417 (1968)

Shielding of Crystal Fields at Rare-Earth Ions—R. M. Sternheimer, M. Blume, and R. F. Peierls. 173, 376 (1968)

Stochastic Theory of Line Shape: Generalization of the Kubo-Anderson Model—M. Blume. 174, 351 (1968)

BOATNER, L. A.
Production of Divalent Thulium in CaO and $SrCl_2$—M. M. Abraham, R. W. Reynolds, and L. A. Boatner. 175, 485 (1968)

BOCCIO, John R.
Unitarity-Analyticity Equations for Elastic Pion-Nucleon Scattering: A Numerical Solution—John R. Boccio. 176, 1934 (1968)

BÖER, K. W.
Stationary High-Field Domains in the Range of Negative Differential Conductivity in CdS Single Crystals—K. W. Böer and P. Voss. 171, 899 (1968)

Electron Mobility in CdS at High Electric Fields—K. W. Böer and K. Bogus. 176, 899 (1968)

BOETTLER, James L.
Luminescent Excitation Spectra of *F* and *M* Centers in KCl—James L. Boettler and W. Dale Compton. 173, 844 (1968)

BOGARDUS, E. Hal
Bound-Exciton, Free-Exciton, Band-Acceptor, Donor-Acceptor, and Auger Recombination in GaAs—E. Hal Bogardus and H. Barry Bebb. 176, 993 (1968)

BOGUS, K.
Electron Mobility in CdS at High Electric Fields—K. W. Böer and K. Bogus. 176, 899 (1968)

BÖHM, A.
A Mass-Splitting Theorem for General Definitions of Mass—A. Böhm and L. O'Raifeartaigh. 171, 1698 (1968)

Derivation of the Mass and Spin Spectrum for Mesons and Baryons—A. Böhm. 175, 1767 (1968)

BOLLINGER, L. M.
*p*-Wave Resonances of $U^{238}$—L. M. Bollinger and G. E. Thomas. 171, 1293 (1968)

BOMSE, F.
Deck-Model Calculation for Doubly Charged $K\pi\pi$ Systems in $KN \to K^*\pi N$ Reactions—F. Bomse and E. J. Moses. 176, 2163 (1968)

BONAR, D. C.
Parity Conservation in the Reaction $T(d,n)He^4$—D. C. Bonar, C. W. Drake, R. D. Headrick, and V. W. Hughes. 174, 1200 (1968)

BONN
Photoproduction of Meson and Baryon Resonances at Energies up to 5.8 GeV—Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration. 175, 1669 (1968)

BORECKA, I.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)

BORELI, F.
Neutron Cross-Section Measurements of $^{12}C$ between 14 and 25 MeV—F. Boreli, B. B. Kinsey, and P. N. Shrivastava. 174, 1147 (1968)

Proton and Neutron Resonances in Nitrogen—F. Boreli, P. N. Shrivastava, B. B. Kinsey, and V. C. Mistry. 174, 1221 (1968)

BORGONOVI, G. M.
Neutron Scattering from MgO—G. M. Borgonovi and G. W. Carriveau. 174, 953 (1968)

BORN, Gunthard K.
Erratum: Recombination of Electrons and Molecular Helium Ions—Gunthard K. Born. [169, 155 (1968)] 173, 325 (1968)

BOSE, Shyamalendu M.
Ground-State Energy of the Anderson Model by the Cluster Variation Method—Shyamalendu M. Bose and Tomoyasu Tanaka. 176, 600 (1968)

BOSI, L.
Data and Speculations on the Electronic Problem for the Relaxed Excited *F* Center—L. Bosi, P. Podini, and G. Spinolo. 175, 1133 (1968)

BOTTERILL, D. R.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)

Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

BOULWARE, David G.
Vector Fields and Current Commutators. II—David G. Boulware. 172, 1625 (1968)

Tree Graphs and Classical Fields—David G. Boulware and Lowell S. Brown. 172, 1628 (1968)

Equal-Time Commutators and Electromagnetic Mass Splittings—David G. Boulware and S. Deser. 175, 1912 (1968)

BOUNIN, Paul
Search for the Contribution of the Longitudinal Virtual Photon in Inelastic Electron-Proton Scattering—Paul Bounin. 176, 1643 (1968)

BOURLAND, P. D.
Range and $dE/dx$ of C, N, O, F, and Ne in Be and C from 500 keV to 2 MeV—W. K. Chu, P. D. Bourland, K. H. Wang, and D. Powers. 175, 342 (1968)

BOWEN, Theodore
Origin of Primary Cosmic Radiation and Its Antiproton Component—J. R. Wayland and Theodore Bowen. 171, 1376 (1968)

BOWERS, R.
Strain-Dependent Magnetoresistance of Potassium—P. A. Penz and R. Bowers. 172, 991 (1968)

BOWLES, P.
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)

BOWMAN, C. D.
Neutron Scattering Cross Sections of $U^{233}$, $U^{235}$, and $Pu^{241}$ from 1 to 30 eV—G. D. Sauter and C. D. Bowman. 174, 1413 (1968)

BOWMAN, W. W.
Stopping Powers of $S^{32}$, $Cl^{35}$, $Br^{79}$, and $I^{127}$ Ions in Mylar—T. E. Pierce, W. W. Bowman, and Marshall Blann. 172, 287 (1968)

BOYD, Richard N.
Nuclear-Matter Sizes in the Tin Isotopic Sequence—Richard N. Boyd and G. W. Greenlees. 176, 1394 (1968)

BOYER, Timothy H.
Quantum Electromagnetic Zero-Point Energy and Retarded Dispersion Forces—Timothy H. Boyer. 174, 1631 (1968)

Quantum Electromagnetic Zero-Point Energy of a Conducting Spherical Shell and the Casimir Model for a Charged Particle—Timothy H. Boyer. 174, 1764 (1968)

BOYNTON, P. E.
Double Charge Exchange of Positive $\pi$ Mesons on Complex Nuclei—P. E. Boynton, Thomas J. Devlin, J. Solomon, and V. Perez-Mendez. 174, 1083 (1968)

BOYS, D. W.
Thermal Conductivities and Lorenz Functions of Dy, Er, and Lu Single Crystals—D. W. Boys and S. Legvold. 174, 377 (1968)

BRADEN, C. H.
Directional Correlations in the Decay of $^{148}$Pm—L. D. Wyly, E. T. Patronis, Jr., and C. H. Braden. 172, 1153 (1968)

BRADLEY, R. H.
$\pi^- p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)

BRAICOVICH, L.
Erratum: Electron Longitudinal Depolarization with Great Energy Loss—L. Braicovich, B. De Michelis, and A. Fasana. [164, 1360 (1967)] 171, 1330 (1968)

Scattering of $\beta$ Radiation on a Thick Foil: Production of Transverse Polarization—L. Braicovich, B. De Michelis, and A. Fasana. 174, 460 (1968)

BRANDENBERGER, J. D.
$^{40}$Ar($p$,$n$)$^{40}$K Reaction from Threshold to 5.0 MeV—T. M. Young, J. D. Brandenberger, and F. Gabbard. 172, 1148 (1968)

BRANDT, Richard A.
Regge Asymptotic Behavior and the Bethe-Salpeter Equation—Richard A. Brandt and Martin Feinroth. 176, 1985 (1968)

BRANDT, Werner
Electric Field Dependence of Positronium Formation in Matter—Werner Brandt and Howard Feibus. 174, 454 (1968)

BRAYSHAW, D. D.
Off- and On-Shell Analyticity of Three-Particle Scattering Amplitudes—D. D. Brayshaw. 176, 1855 (1968)

BREHM, J. J.
Pion Form-Factor Zero and "Dipole" Nucleon Structure—J. J. Brehm and L. F. Cook. 174, 1901 (1968)

BRESSAN, O. J.
Thermal and Electrical Conductivities of Very-High-Purity Indium—M. E. de la Cruz, F. de la Cruz, J. M. Cotignola, O. J. Bressan, and C. A. Luengo. 176, 871 (1968)

BRET, Georges
Investigation of Rayleigh Wings and Brillouin-Stimulated Scattering in Liquids—Marguerite Denariez and Georges Bret. 171, 160 (1968)

BRETZ, Michael
Statistical Mechanics of Monolayers of Bose and Fermi Atoms Adsorbed on Crystalline Surfaces—J. G. Dash and Michael Bretz. 174, 247 (1968)

BRIDWELL, L. B.
Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10-180 MeV—C. D. Moak, H. O. Lutz, L. B. Bridwell, L. C. Northcliffe, and S. Datz. 176, 427 (1968)

BRINKMAN, W. F.
Sum Rule for the Landau Fermi-Liquid Parameters in Metals—W. F. Brinkman, P. M. Platzman, and T. M. Rice. 174, 495 (1968)

BRITT, H. C.
Characteristics of the Transition-State Spectra for $^{234}$U, $^{238}$U, and $^{240}$Pu from ($d$,$pf$) and ($t$,$pf$) Angular-Correlation Experiments—H. C. Britt, F. A. Rickey, Jr., and W. S. Hall. 175, 1525 (1968)

BRODSKY, M. B.
Isomer Shift and Hyperfine Splittings of the 59.6-keV Mössbauer Resonance in $^{237}$Np—B. D. Dunlap, G. M. Kalvius, S. L. Ruby, M. B. Brodsky, and D. Cohen. 171, 316 (1968)

BRODSKY, Stanley J.
Second Born Corrections to Wide-Angle High-Energy Electron Pair Production and Bremsstrahlung—Stanley J. Brodsky and John R. Gillespie. 173, 1011 (1968)

Electromagnetic Interactions of Loosely-Bound Composite Systems—Stanley J. Brodsky and Joel R. Primack. 174, 2071 (1968)

Erratum: Precise Theory of the Zeeman Spectrum for Atomic Hydrogen and Deuterium and the Lamb Shift—Stanley J. Brodsky and Ronald G. Parsons. [163, 134 (1967)] 176, 423 (1968)

BRODY, A. P.
Determination of the Number of Unique Configurations of Unrelaxed Clusters in Crystal Lattices—A. P. Brody and M. Meshii. 176, 845 (1968)

BRODZINSKI, R. L.
Fission of Iridium at Intermediate Excitation Energies—R. L. Brodzinski and J. W. Cobble. 172, 1194 (1968)

BROIDO, Michael M.
Does Lorentz-Invariance Imply Causality?—Michael M. Broido and John G. Taylor. 174, 1606 (1968)

BROLLEY, John E.
Velocity-Dependent Potential Parametrization for $^1S_0$ Elastic Proton-Proton Scattering—John E. Brolley. 171, 1439 (1968)

BRONZAN, J. B.
Third Sector of the Lee Model—J. B. Bronzan. 172, 1429 (1968)

Analyticity and Broken $O(4)$ Symmetry—J. B. Bronzan, C. Edward Jones, and P. K. Kuo. 175, 2200 (1968)

BROOKS, Harvey
Ordering Energy and Effective Pairwise Interactions in a Binary Alloy of Simple Metals—Timothy M. Hayes, Harvey Brooks, and Arthur Bienenstock. 175, 699 (1968)

BROSS, Helmut
Limitation of the Phonon Heat Conductivity by Edge-Dislocation Dipoles, Single Dislocations, and Normal Processes—Peter Gruner and Helmut Bross. 172, 583 (1968)

BROTHERS, A. D.
Photochemical Conversion of $F$ Centers to $M$ Centers in KCl, KBr, and CsBr—A. D. Brothers and D. W. Lynch. 174, 958 (1968)

BROWER, Richard C.
Regge-Pole Model with the $M = 1$ Pion in $\pi^+ p \to \rho^0 \Delta^{++}$ and $\pi^+ p \to \rho^+ p$ Scattering—Farzam Arbab and Richard C. Brower. 175, 1991 (1968)

Pion Photoproduction, $NN$ Scattering, and Photoproduction Sum Rules—Richard C. Brower and Jan W. Dash. 175, 2014 (1968)

BROWN, Lowell S.
Tree Graphs and Classical Fields—David G. Boulware and Lowell S. Brown. 172, 1628 (1968)

Soft Photons and the Classical Limit—Lowell S. Brown and Robert L. Goble. 173, 1505 (1968)

BROWN, R. A.
Pressure Shifts of Hyperfine Splitting of Hydrogen and Tritium in Argon—R. A. Brown and F. M. Pipkin. 174, 48 (1968)

BROWN, R. D.
Tilt of the Electron Fermi Surface in Bi—R. D. Brown, R. L. Hartman, and S. H. Koenig. 172, 598 (1968)
BROWN, R. F.
Magnetocrystalline Anisotropy of Europium Selenide—R. F. Brown, A. W. Lawson, and Glen E. Everett. 172, 559 (1968)
BROWN, R. M.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)
BROWN, Ronald E.
Search for Unbound States in $He^3$ through $Li^6(p,\alpha)$—David K. Olsen and Ronald E. Brown. 176, 1192 (1968)
Study of $He^3$+$He^4$ and $H^3$+$He^4$ Systems with the Resonating-Group Method—Ronald E. Brown and Y. C. Tang. 176, 1235 (1968)
BROWN, Stanley G.
Bjorken Limit and Pole Dominance. I. The $\omega\rho\pi$ System and the Algebra of Fields—Stanley G. Brown and Geoffrey B. West. 174, 1777 (1968)
Bjorken Limit and Pole Dominance. II. Virtual $\pi\rho$ Scattering—Stanley G. Brown and Geoffrey B. West. 174, 1786 (1968)
BROYLES, A. A.
A Parametric Approach to the Ground-State Energy of an Electron Gas—M. S. Becker, A. A. Broyles, and Tucson Dunn. 175, 224 (1968)
BRUCKER, E. B.
$\pi^- p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)
BRUECKNER, Keith A.
Statistical Theory of Nuclei—K. A. Brueckner, J. R. Buchler, S. Jorna, and R. J. Lombard. 171, 1188 (1968)
New Theoretical Approach to Nuclear Heavy-Ion Scattering—Keith A. Brueckner, J. Robert Buchler, and Michael M. Kelly. 173, 944 (1968)
Laser-Induced Instabilities in Raman-Active Media—Keith A. Brueckner and Sadanand S. Rangnekar. 175, 332 (1968)
BRUNNADER, H.
Carbon-10 and Mass Measurements for Light Nuclei—H. Brunnader, J. C. Hardy, and Joseph Cerny. 174, 1247 (1968)
BRUST, David
High-Resolution Study of the One-Electron Spectrum of Si—Luis R. Saravia and David Brust. 171, 916 (1968)
Dielectric Singularity of α-Sn—L. Liu and David Brust. 173, 777 (1968)
Band-Structure Effects and Many-Particle Scattering Corrections in the Far-Ultraviolet Spectra of Ge and Si—David Brust and Evan O. Kane. 176, 894 (1968)
Spin Splitting and the Ultraviolet Absorption of Ge—Luis R. Saravia and David Brust. 176, 915 (1968)
BRYSK, H.
Photoelectric Cross Sections in the keV Range—H. Brysk and C. D. Zerby. 171, 292 (1968)
BUBE, Richard H.
Photoelectronic Properties of ZnSe Crystals—Gerald B. Stringfellow and Richard H. Bube. 171, 903 (1968)
BUCHANAN, D. N. E.
Magnetic Properties of the Planar Antiferromagnet $Rb_2FeF_4$—G. K. Wertheim, H. J. Guggenheim, H. J. Levinstein, D. N. E. Buchanan, and R. C. Sherwood. 173, 614 (1968)
BUCHANAN, R. A.
Infrared Dispersion and Lattice Vibrations of $LaF_3$—H. E. Rast, H. H. Caspers, S. A. Miller, and R. A. Buchanan. 171, 1051 (1968)
BUCHLER, J. Robert
Statistical Theory of Nuclei—K. A. Brueckner, J. R. Buchler, S. Jorna, and R. J. Lombard. 171, 1188 (1968)
New Theoretical Approach to Nuclear Heavy-Ion Scattering—Keith A. Brueckner, J. Robert Buchler, and Michael M. Kelly. 173, 944 (1968)
BUCKMAN, A. B.
Electroreflectance Changes in Dielectric Constants of Au and Ag by Modulated Ellipsometry—A. B. Buckman and N. M. Bashara. 174, 719 (1968)
BUDD, H. F.
Transport Theory in Strong Magnetic Fields—H. F. Budd. 175, 241 (1968)
BUDINI, P.
Majorana Equations for Composite Systems—G. Bisiacchi, P. Budini, and G. Calucci. 172, 1508 (1968)
BUDNITZ, R. J.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)
BUFFINGTON, A.
$\bar{K}^0$ and $\Lambda^0$ Production in $K^- + p$ Interactions at 7.7 GeV/$c$—A. Buffington and C. E. W. Ward. 176, 1621 (1968)
Charge-Exchange $K^- + p \to \bar{K}^0 + n$ at 7.7 GeV/$c$—A. Buffington, D. H. Frisch, and C. E. W. Ward. 176, 1628 (1968)
BUONTEMPO, U.
Ion Mobility Discontinuities in Superfluid Helium: A Test of the Huang-Olinto Theory—D. L. Goodstein, U. Buontempo, and M. Cerdonio. 171, 181 (1968)
BURCKBUCHLER, F. V.
Effect of Antimony, Indium, and Zinc Impurities on the Critical-Field Curve of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 543 (1968)
Anisotropy of the Residual Resistivity of Tin with Sb, In, Zn, and Cd Impurities, and the Ideal Resistivities and Deviations from Matthiessen's Rule at 77 and 273°K—F. V. Burckbuchler and C. A. Reynolds. 175, 550 (1968)
Calculation of the Effect of Superconducting Energy-Gap Anisotropy on the Thermal Conductivity of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 556 (1968)
BURGESS, D. D.
Contribution of Perturber Radiation to the Shapes of Spectral Lines Broadened by Electron Impacts—D. D. Burgess. 176, 150 (1968)
BURKE, E. A.
Calculation of the $^1S$ State of the Beryllium Atom in Hylleraas Coordinates—R. F. Gentner and E. A. Burke. 176, 63 (1968)
BURKE, William
Magnetic Circular Dichroism of the $R$ Center in KCl—William Burke. 172, 886 (1968)

BURMAN, R. L.
Pion Double-Charge-Exchange Cross-Section Measurements—C. J. Cook, M. E. Nordberg, Jr., and R. L. Burman. 174, 1374 (1968)

BURNETT, T. H.
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)

BURNHAM, David C.
Photon Echo in Gaseous Media—M. Scully, M. J. Stephen, and David C. Burnham. 171, 213 (1968)

BURNSTEIN, R. A.
Low-Energy Λ-Proton Elastic Scattering—B. Sechi-Zorn, B. Kehoe, J. Twitty, and R. A. Burnstein. 175, 1735 (1968)

BURTON, J. J.
Fermi Momentum of Aluminum from 0 to 100 kbar—J. J. Burton and G. Jura. 171, 699 (1968)

CAHILL, Patrick
Theory of Polarization of Molecular Line Radiation Excited by Electron Impact—A. Norman Jette and Patrick Cahill. 176, 186 (1968)

CAIRNS, R. B.
Photoelectron Spectroscopy of the Rare Gases—James A. R. Samson and R. B. Cairns. 173, 80 (1968)

CALAWA, A. R.
Tuning of PbSe Lasers by Hydrostatic Pressure from 8 to 22 μ—J. M. Besson, William Paul, and A. R. Calawa. 173, 699 (1968)

CALLAWAY, Joseph
Elastic Scattering of Low-Energy Electrons from Metastable Helium—Ralph C. Sklarew and Joseph Callaway. 175, 103 (1968)

CALOGERO, F.
Approximate Bounds on Coupling Constants from Analyticity, Crossing, and Unitarity—D. Atkinson and F. Calogero. 171, 1767 (1968)

CALUCCI, G.
Majorana Equations for Composite Systems—G. Bisiacchi, P. Budini, and G. Calucci. 172, 1508 (1968)

CAMPBELL, J. H.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

CAMPBELL, L. J.
Concentration-Dependent Polarization in $He^3$-$He^4$ Solutions—L. J. Campbell. 176, 225 (1968)

CANTELLI, R.
Mobility of Positive and Negative Charges in $^3He$ at the Critical Point—R. Cantelli, I. Modena, and F. P. Ricci. 171, 236 (1968)

CANTER, J.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

CANUTO, Vittorio
Quantum Theory of an Electron Gas in Intense Magnetic Fields—Vittorio Canuto and Hong-Yee Chiu. 173, 1210 (1968)

Thermodynamic Properties of a Magnetized Fermi Gas—Vittorio Canuto and Hong-Yee Chiu. 173, 1220 (1968)

Magnetic Moment of a Magnetized Fermi Gas—Vittorio Canuto and Hong-Yee Chiu. 173, 1229 (1968)

Quantum Theory of an Electron Gas with Anomalous Magnetic Moments in Intense Magnetic Fields—Hong-Yee Chiu, Vittorio Canuto, and Laura Fassio-Canuto. 176, 1438 (1968)

CAPE, J. A.
Magnetic and Crystallographic Transitions in the $\alpha$-$Mn_2O_3$–$Fe_2O_3$ System—R. W. Grant, S. Geller, J. A. Cape, and G. P. Espinosa. 175, 686 (1968)

CAPELLA, A.
Factorization and Constraints in Regge-Pole Theory—A. Capella, A. P. Contogouris, and J. Tran Thanh Van. 175, 1892 (1968)

CAPON, G.
Proton Compton Effect by Polarized Photons at 90° in the c.m. System in the First Resonance Region—G. Barbiellini, G. Capon, G. De Zorzi, and G. P. Murtas. 174, 1665 (1968)

CAPPS, Richard H.
Induction of Symmetries for a Set of Mesons of Both Parities—Richard H. Capps. 171, 1591 (1968)

CARBOTTE, J. P.
Superconductivity in Simple Metals—J. P. Carbotte and R. C. Dynes. 172, 476 (1968)

Phonon-Limited Resistivity of Some Simple Metals—R. C. Dynes and J. P. Carbotte. 175, 913 (1968)

CARDONA, Manuel
Piezo-Electroreflectance in Ge, GaAs, and Si—Fred H. Pollak and Manuel Cardona. 172, 816 (1968)

Electro-Optic Measurements of PbS, PbSe, and PbTe—D. E. Aspnes and M. Cardona. 173, 714 (1968)

New Evidence for the Existence of Exciton Effects at Hyperbolic Critical Points—Kerry L. Shaklee, J. E. Rowe, and Manuel Cardona. 174, 828 (1968)

Electroreflectance Measurements on $Mg_2Si$, $Mg_2Ge$, and $Mg_2Sn$—F. Vazquez, Richard A. Forman, and Manuel Cardona. 176, 905 (1968)

Thermoreflectance in Semiconductors—E. Matatagui, A. G. Thompson, and Manuel Cardona. 176, 950 (1968)

CARLSON, D. E.
Magnetic-Field Dependence of Radio-Frequency Flux Penetration in Type-II Superconductors—D. E. Carlson and W. L. McLean. 176, 538 (1968)

CARLSON, Thomas A.
Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions—Thomas C. Tucker, Louis D. Roberts, C. W. Nestor, Jr., Thomas A. Carlson, and F. B. Malik. 174, 118 (1968)

CARLSTONE, D. S.
Embedding of $SU(3)$ in $SU(8)$—D. S. Carlstone. 171, 1527 (1968)

Pole Models for $S$-Wave Hyperon Decay—D. S. Carlstone, S. P. Rosen, and S. Pakvasa. 174, 1877 (1968)

CARMEL, Z.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)

CARMI, Gideon
Circular One-Dimensional Model for the Electron-Ion System. I. Random-Phase Approximation—Gideon Carmi. 176, 510 (1968)

Circular One-Dimensional Model for the Electron-Ion System. II. First-Order Phase Transitions in the Random-Phase Approximation—Gideon Carmi. 176, 521 (1968)

CARPENTER, D. W.
Upper Limit on the Decay Rate $K_L^0 \to \pi^0\pi^0\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)

CARR, Paul H.
Erratum: Second-Harmonic Generation of Microwave Phonons in Quartz and Sapphire—Paul H. Carr. [169, 719 (1968)] 173, 325 (1968)

CARRICO, J. P.
Electric Dipole Moments of Alkali Atoms. A Limit to the Electric Dipole Moment of the Free Electron—J. P. Carrico, E. Lipworth, P. G. H. Sandars, T. S. Stein, and M. C. Weisskopf. 174, 125 (1968)

CARRIVEAU, G. W.
Neutron Scattering from MgO—G. M. Borgonovi and G. W. Carriveau. 174, 953 (1968)

CARROLL, James
Electromagnetic Properties of Baryons in a Quark-Diquark Model with Broken $SU(6)$—James Carroll, D. B. Lichtenberg, and J. Franklin. 174, 1681 (1968)

CARROLL, L.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)

CARRUTHERS, P.
Local Field Theory and Isospin Invariance. III. Interactions of Self-Conjugate Isofermion Fields—P. Carruthers. 172, 1406 (1968)

CARTER, Benjamin P.
$2P\frac{1}{2}$ States of Muonic Molecules—Benjamin P. Carter. 173, 55 (1968)

CARTER, Brandon
Global Structure of the Kerr Family of Gravitational Fields—Brandon Carter. 174, 1559 (1968)

CARTER, H. K.
Evidence for a 0+ State in $^{68}$Zn Populated by $^{68}$Ga—H. K. Carter, J. H. Hamilton, A. V. Ramayya, and J. J. Pinajian. 174, 1329 (1968)

CARTER, J. C.
Decays of Odd-Parity Baryon Resonances—J. C. Carter and M. E. M. Head. 176, 1808 (1968)

CARTWRIGHT, David C.
Rearrangement Collisions: Effect of Core Terms, Nonorthogonality, and Conservation of Particle Flux on Approximate Theories—Donald G. Truhlar, David C. Cartwright, and Aron Kuppermann. 175, 113 (1968)

CASE, Lloyd A.
Changes of the Petrov Type of a Space-Time—Lloyd A. Case. 176, 1554 (1968)

CASELLA, R. C.
Decay Modes with Coherent Resonant-Energy Transfer between Deep Impurities in Solids—R. C. Casella. 174, 830 (1968)

CASON, N. M.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

CASPERS, H. H.
Infrared Dispersion and Lattice Vibrations of $LaF_3$—H. E. Rast, H. H. Caspers, S. A. Miller, and R. A. Buchanan. 171, 1051 (1968)

CASTLE J. G., Jr.
Spin Relaxation via Low-Lying Energy Level of $Fe^{2+}$ in MgO—E. L. Wilkinson, R. L. Hartman, and J. G. Castle, Jr. 171, 299 (1968)

CELENZA, Louis
Erratum: Generalized Hartree-Fock Approximation for Nucleon-Nucleon Scattering—Louis Celenza. [168, 1189 (1968)] 172, 1282 (1968)

Calculation of the Lifetime of a Metastable System—L. Celenza and W. Tobocman. 174, 1115 (1968)

CELLI, V.
Vibrational Modes of a Negative Ion in Liquid Helium—V. Celli, Morrel H. Cohen, and M. J. Zuckerman. 173, 253 (1968)

CELOTTA, Robert J.
Measurement of the Electric Dipole Polarizabilities of Metastable Mercury—Judah Levine, Robert J. Celotta, and Benjamin Bederson. 171, 31 (1968)

CERDONIO, M.
Ion Mobility Discontinuities in Superfluid Helium: A Test of the Huang-Olinto Theory—D. L. Goodstein, U. Buontempo, and M. Cerdonio. 171, 181 (1968)

CERNY, Joseph
Carbon-10 and Mass Measurements for Light Nuclei—H. Brunnader, J. C. Hardy, and Joseph Cerny. 174, 1247 (1968)

Observation of the Lowest $p$-Shell $T=\frac{1}{2}$ States of $^{11}$B and $^{11}$C—S. W. Cosper, Robert L. McGrath, Joseph Cerny, Creve C. Maples, George W. Goth, and Donald G. Fleming. 176, 1113 (1968)

CETAS, T. C.
Specific Heats of Cu, GaAs, GaSb, InAs, and InSb from 1 to 30°K—T. C. Cetas, C. R. Tilford, and C. A. Swenson. 174, 835 (1968)

CHAN, C. H.
Renormalization of the Strangeness-Changing Axial-Vector Coupling Constants—C. H. Chan and F. T. Meiere. 175, 2222 (1968)

CHAN, Francis C. P.
Nonleptonic Decays of Hyperons and Current Algebra—Francis C. P. Chan. 171, 1543 (1968)

CHAN, F. T.
Estimation of the Cross Sections for Collision Transfer of Excitation in Helium—F. T. Chan. 172, 96 (1968)

CHAN, Y. W.
Magnetic Hyperfine Interaction Constants and Electronic $g$ Factors for Eight Atomic States of $Rh^{103}$—Y. W. Chan, W. J. Childs, and L. S. Goodman. 173, 107 (1968)

CHANDLER, Colston
Causality in $S$-Matrix Theory—Colston Chandler. 174, 1749 (1968)

CHANDLER, Louis
Quadrupolar Hyperfine Anisotropy in $Fe(NH_4SO)_2 \cdot 6H_2O$ and Its Comparison with the Magnetic Susceptibility—R. Ingalls, K. Ono, and Louis Chandler. 172, 295 (1968)

CHANDRASEKHAR, B. S.
Precision Measurement of Anisotropy in the Upper Critical Field of Superconducting Niobium—D. E. Farrell, B. S. Chandrasekhar, and S. Huang. 176, 562 (1968)

CHANG, Edward S.
Many-Body Approach to the Atomic Hyperfine Problem. I. Lithium-Atom Ground State—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 1 (1968)

Many-Body Calculation of Atomic Polarizability—Relation to Hartree-Fock Theory—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 16 (1968)

Photo-Ionization of Lithium: A Many-Body Calculation—Edward S. Chang and M. R. C. McDowell. 176, 126 (1968)

CHANG, I. F.
Application of a Modified Random-Element-Isodisplacement Model to Long-Wavelength Optic Phonons of Mixed Crystals—I. F. Chang and S. S. Mitra. 172, 924 (1968)
Optical Phonons of Yttrium Aluminum Garnet—J. P. Hurrell, S. P. S. Porto, I. F. Chang, S. S. Mitra, and R. P. Bauman. 173, 851 (1968)
CHANG, L. L.
Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)
CHANG, Ngee-Pong
Impact Parametrization of the Scattering Amplitude—Ngee-Pong Chang. 172, 1796 (1968)
High-Energy Large-Angle Proton-Proton Scattering—Ngee-Pong Chang. 175, 1741 (1968)
Lorentz Poles and Bethe-Salpeter Equations: Does an Infinite Number of Lorentz Poles Exist?—N. P. Chang and R. P. Saxena. 176, 2101 (1968)
CHANG, R. K.
Optical Third-Harmonic Generation in Dye Solutions—R. K. Chang and Lee K. Galbraith. 171, 993 (1968)
Optical Second-Harmonic Generation in Reflection from Media with Inversion Symmetry—N. Bloembergen, R. K. Chang, S. S. Jha, and C. H. Lee. 174, 813 (1968)
CHANG, Shau-Jin
Coupling of the Spacelike and Timelike Wave Functions at Infinite Momentum—Shau-Jin Chang and L. O'Raifeartaigh. 171, 1587 (1968)
CHANTRY, P. J.
Dissociative Attachment in CO and NO—P. J. Chantry. 172, 125 (1968)
CHAPPLE, Frances H.
Photoconductivity in Colored Potassium Chloride—Frances H. Chapple, Gerhard Lehmann, and Allen B. Scott. 174, 1012 (1968)
CHASE, C. E.
Velocity of Sound at 1 MHz Near the $He^4$ Critical Point—R. C. Williamson and C. E. Chase. 176, 285 (1968)
CHASE, L. F., Jr.
$Ne^{22}(t,p\gamma)Ne^{24}$ Angular Correlation Study—J. A. Becker, L. F. Chase, Jr., R. E. McDonald, and E. K. Warburton. 176, 1310 (1968)
CHASMAN, C.
Gamma Rays from the $Sc^{45}(p,p'\gamma)$ Reaction—C. Chasman, K. W. Jones, and R. A. Ristinen. 173, 1072 (1968)
CHATRAPHORN, S.
Neutron Diffraction by Liquid Zinc—B. A. Dasannacharya, Q. O. Navarro, H. Ibarra, S. Chatraphorn, and G. B. Lee. 173, 241 (1968)
CHATTARJI, Dipankar
Relativistic Study of $KL_1L_1$ Auger Transition Probabilities—Dipankar Chattarji and Benoy Talukdar. 174, 44 (1968)
CHATTERJEE, Aruna
Rare Decay Mode $\eta \to \pi^+\pi^-\pi^0\gamma$ and the Relation between Vector-Dominance and Current-Algebra Calculations—Aruna Chatterjee. 174, 1832 (1968)
CHAUDHURI, R. N.
Final-State Interactions in $\eta \to 3\pi$ and $K_2^0 \to 3\pi$ Decays—R. N. Chaudhuri. 175, 2066 (1968)
Current Algebra and $K^*\Lambda$ Photoproduction—Debabrata Basu and R. N. Chaudhuri. 175, 2075 (1968)
CHEN, C. L.
Self-Broadening of Cesium Resonance Lines at 8521 and 8944 Å—C. L. Chen and A. V. Phelps. 173, 62 (1968)
CHEN, Inan
Optical Phonons and Dynamic Charge in Trigonal Se and Te—Inan Chen and Richard Zallen. 173, 833 (1968)
CHEN, J.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)
CHEN, Joseph C. Y.
Faddeev Equations for Atomic Problems and Solutions for the $(e, H)$ System—James S. Ball, Joseph C. Y. Chen, and David Y. Wong. 173, 202 (1968)
Electronic Transitions in Slow Collisions of Atoms and Molecules. I—Joseph C. Y. Chen and Kenneth M. Watson. 174, 152 (1968)
Formal Problems in the Theory of Dissociative Attachment and Recombination—Joseph C. Y. Chen and Marvin H. Mittleman. 174, 185 (1968)
CHEN, K.
Effects of Using a Velocity-Dependent Potential in a Monte Carlo Simulation of Intranuclear Cascades—K. Chen, G. Friedlander, and J. M. Miller. 176, 1208 (1968)
CHEN, K. Wendell
Experimental Study of the Decay $K_L^0 \to \pi + e + \nu$—S. H. Aronson and K. Wendell Chen. 175, 1708 (1968)
CHEN, Y.
Erratum: Subthreshold Electron Damage in $n$-Type Germanium—Y. Chen and J. W. MacKay. [167, 745 (1968)] 173, 918 (1968)
CHEN-CHEUNG, Fei S.
Study of $\pi N$ and $KN$ Elastic and Inelastic Scatterings and their Polarizations by a Multiple-Regge-Pole Model—Fei S. Chen-Cheung and Timothy Roth. 173, 1768 (1968)
CHENG, Jack C.
Faraday Rotation of the CaO $F$ Band and 3557 Å Zero-Phonon Peak—James C. Kemp, William M. Ziniker, James A. Glaze, and Jack C. Cheng. 171, 1024 (1968)
CHENG, L. J.
Characteristics of Neutron Damage in Silicon—L. J. Cheng and J. Lori. 171, 856 (1968)
CHENG, T. P.
Broken $SU(3)$ Symmetry, Sum Rules, and the Magnetic Moments of the Baryons—T. P. Cheng and Heinz Pagels. 172, 1635 (1968)
Low-Energy Theorems for $e^4$ Compton Scattering Amplitudes—T. P. Cheng. 176, 1674 (1968)
CHERN, B.
Model Dependence of Corrections to the Fermi Function and $ft$ Values of Some $0^+ \to 0^+$ Super-Allowed $\beta$ Decays, and the Value of the Vector Coupling Constant—T. A. Halpern and B. Chern. 175, 1314 (1968)
Static Coulomb Corrections to the Point-Nucleus Fermi Function in Nuclear Beta Decay—L. J. Logue and B. Chern. 175, 1367 (1968)
CHERTOK, B. T.
Comparison of Experiment and Theory for Nuclear Excitation in $^{115}In$ by Threshold-Energy Electrons—B. T. Chertok and W. T. K. Johnson. 174, 1525 (1968)
CHESTER, G. V.
On the Theory of Quantized Vortices—G. V. Chester, R. Metz, and L. Reatto. 175, 275 (1968)

CHEUNG, Franklin F. K.
Scattering Model with Crossing Symmetry and Minimal Inelastic Effects—Franklin F. K. Cheung and John S. Toll. 173, 1791 (1968)

CHEVALLIER, P.
Gamma Decays from the First $T=\frac{1}{2}$ Levels in $^{13}N$ and $^{13}C$—C. L. Cocke, J. C. Adloff, and P. Chevallier. 176, 1120 (1968)

CHEW, G. F.
Multiperipheral Bootstrap Model—G. F. Chew and A. Pignotti. 176, 2112 (1968)

CHICKLIS, E.
Ground-State Modulation Using Optical Double Resonance in Trivalent Rare-Earth-Doped Single Crystals—L. Esterowitz and E. Chicklis. 174, 463 (1968)

CHILD, H. R.
Magnetic Structure Properties of Alloys of Tb, Ho, and Er with Sc—H. R. Child and W. C. Koehler. 174, 562 (1968)
Magnetic Structures of $Er_2O_3$ and $Yb_2O_3$—R. M. Moon, W. C. Koehler, H. R. Child, and L. J. Raubenheimer. 176, 722 (1968)
Note on the Scattering Cross Sections of the Isotopes of Dysprosium—H. R. Child, L. J. Raubenheimer, W. C. Koehler, and R. M. Moon. 174, 1553 (1968)

CHILDERS, R. W.
Centrifugal-Barrier Effects in $N/D$ Calculations—R. W. Childers and A. W. Martin. 171, 1540 (1968)

CHILDS, J.
Magnetic Hyperfine Interaction Constants and Electronic $g$ Factors for Eight Atomic States of $Rh^{103}$—Y. W. Chan, W. J. Childs, and L. S. Goodman. 173, 107 (1968)

CHINOWSKY, W.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)

CHIU, Hong-Yee
Quantum Theory of an Electron Gas in Intense Magnetic Fields—Vittorio Canuto and Hong-Yee Chiu. 173, 1210
Thermodynamic Properties of a Magnetized Fermi Gas—Vittorio Canuto and Hong-Yee Chiu. 173, 1220 (1968)
Magnetic Moment of a Magnetized Fermi Gas—Vittorio Canuto and Hong-Yee Chiu. 173, 1229 (1968)
Quantum Theory of an Electron Gas with Anomalous Magnetic Moments in Intense Magnetic Fields—Hong-Yee Chiu, Vittorio Canuto, and Laura Fassio-Canuto. 176, 1438 (1968)

CHO, C. W.
Stimulated Thermal Rayleigh Scattering in Liquids—C. W. Cho, N. D. Foltz, D. H. Rank, and T. A. Wiggins. 175, 271 (1968)

CHO, Y.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

CHOH, Sung Ho
Nuclear and Electron Resonance Study of the Paramagnetic Cobalt Ion—Sung Ho Choh and G. S. Seidel. 174, 385 (1968)

CHOI, Chan Kyoo
Angular Dependence of $2^3S$ Excitation of He by High-Energy Electron Impact—Ik-Ju Kang and Chan Kyoo Choi. 171, 123 (1968)

CHOU, T. T.
Model of High-Energy Elastic Scattering and Diffractive Excitation Processes in Hadron-Hadron Collisions—T. T. Chou and C. N. Yang. 175, 1832 (1968)
Model of High-Energy Meson Photoproduction—T. T. Chou. 176, 2041 (1968)

CHOUDHURY, D. K.
Recoil and Rescattering Effects in the Strong Decays of Higher Mesons in the Quark Model—D. K. Choudhury. 174, 2101 (1968)

CHOW, W. S.
Theory of Superconductors with Overlapping Bands in the Presence of Nonmagnetic Impurities—W. S. Chow. 172, 467 (1968)
Upper Critical Field of Two-Band Superconductors Containing Nonmagnetic Impurities—W. S. Chow. 176, 525 (1968)

CHOYKE, W. J.
Higher Absorption Edges in 6$H$ SiC—W. J. Choyke and Lyle Patrick. 172, 769 (1968)
Phonon Dispersion Curves by Raman Scattering in SiC, Polytypes 3C, 4$H$, 6$H$, 15$R$, and 21$R$—D. W. Feldman, James H. Parker, Jr., W. J. Choyke, and Lyle Patrick. 173, 787 (1968)

CHRIEN, R. E.
$Au^{197}(n,\gamma)Au^{198}$ Reaction Mechanism—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 173, 1170 (1968)
Neutron Cross Sections and Resonance Parameters of Yb Isotopes—S. F. Mughabghab and R. E. Chrien. 174, 1400 (1968)
Resonant and Nonresonant Capture of Slow Neutrons in $Tm^{169}(n,\gamma)Tm^{170}$—M. A. Lone, R. E. Chrien, O. A. Wasson, M. Beer, M. R. Bhat, and H. R. Muether. 174, 1512 (1968)
Direct Neutron Capture in $Co^{59}(n,\gamma)Co^{60}$—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 176, 1314 (1968)

CHRIST, N.
Renormalizable Theory of the Weak Interactions—N. Christ. 176, 2086 (1968)

CHRISTIANSEN, P. Voetmann
Ginzburg-Landau Theory of Surface Superconductivity and Magnetic Hysteresis—P. Voetmann Christiansen and Henrik Smith. 171, 445 (1968)

CHRISTOPHER, J. E.
Experiments with Tunnel Junctions Using Ferromagnetic Metals—J. E. Christopher, R. V. Coleman, Acar Isin, and R. C. Morris. 172, 485 (1968)

CHU, C. W.
Superconductivity of $\alpha$-Phase U-Mo Alloys at Zero and High Pressures—J. E. Gordon, W. E. Gardner, T. F. Smith, C. W. Chu, and M. B. Maple. 176, 556 (1968)

CHU, Shu-Yuan
Pion Conspiracy and Pion Residue from the Finite-Energy Photoproduction Sum Rule—D. P. Roy and Shu-Yuan Chu. 171, 1762 (1968)
Crossing-Symmetric Rising Regge Trajectories—Shu-Yuan Chu, Gary Epstein, Peter E. Kaus, Richard C. Slansky, and Fredrik Zachariasen. 175, 2098 (1968)

CHU, W. K.
Range and $dE/dx$ of C, N, O, F, and Ne in Be and C from 500 keV to 2 MeV—W. K. Chu, P. D. Bourland, K. H. Wang, and D. Powers. 175, 342 (1968)

CHU, Y. Y.
Alpha Branching Ratio in the Decay of $^{149}Tb$—Y. Y. Chu, E. M. Franz, and G. Friedlander. 175, 1523 (1968)

CHUNG, Kwong T.
Fully Coupled Hartree-Fock Calculations of the Refractive Index. Dynamic Polarizability and Verdet Coefficients of Helium, Beryllium, and Neon—V. G. Kaveeshwar, Kwong T. Chung, and R. P. Hurst. 172, 35 (1968)

CHUPP, E. L.
Radiative Mean-Life Measurements of Some Atomic-Hydrogen Excited States Using Beam-Foil Excitation—E. L. Chupp, L. W. Dotchin, and D. J. Pegg. 175, 44 (1968)

CIAFALONI, M.
Asymptotic Behavior of Form Factors for Some Composite Models—M. Ciafaloni and P. Menotti. 173, 1575 (1968)
Model Dependence of the Asymptotic Behavior of Form Factors for Relativistic Composite Models—M. Ciafaloni. 176, 1898 (1968)

CICUTA, G. M.
Quark Interactions and Nucleon Form Factors—G. M. Cicuta, G. Marchesini, and A. Scotti. 175, 2113 (1968)

CLAPP, Philip C.
Correlation Functions of Disordered Binary Alloys. II—Philip C. Clapp and S. C. Moss. 171, 754 (1968)
Correlation Functions of Disordered Binary Alloys. III—S. C. Moss and Philip C. Clapp. 171, 764 (1968)

CLARK, B. C.
Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)

CLARK, J. B.
Effect of Pressure on the Polymorphism and Melting Points of the Thallous Halides—Carl W. F. T. Pistorius and J. B. Clark. 173, 692 (1968)

CLARKSON, R.
Dynamic Polarization of Protons in Copper Tutton Salts (Dilute $CuK_4SO_4 \cdot 6H_2O$) and Their Spin-Lattice Relaxation Times—J. S. Karra, R. Clarkson, and T. Sato. 175, 479 (1968)

CLEARY, Robert M.
Scattering of Single-Particle Excitations by a Vortex in a Clean Type-II Superconductor—Robert M. Cleary. 175, 587 (1968)

CLEGG, A. B.
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

CLEM, John R.
Motion of Normal Regions Along a Superconducting Strip—John R. Clem. 176, 531 (1968)

COBBLE, J. W.
Ternary Fission of $U^{238}$ Induced by Intermediate-Energy Helium Ions—R. H. Iyer and J. W. Cobble. 172, 1186 (1968)
Fission of Iridium at Intermediate Excitation Energies—R. L. Brodzinski and J. W. Cobble. 172, 1194 (1968)

COCKE, C. L.
Gamma Decays from the First $T=\frac{1}{2}$ Levels in $^{13}N$ and $^{13}C$—C. L. Cocke, J. C. Adloff, and P. Chevallier. 176, 1120 (1968)

CODY, G. D.
Magnetic Transitions of Superconducting Thin Films and Foils. II. Tin—R. E. Miller and G. D. Cody. 173, 494 (1968)

COHEN, B. L.
$s_{1/2}$-$h_{11/2}$ Anomaly in Stripping Studies near $A=110$—B. L. Cohen, R. A. Moyer, J. B. Moorhead, L. H. Goldman, and R. C. Diehl. 176, 1401 (1968)

COHEN, D.
Isomer Shift and Hyperfine Splittings of the 59.6-keV Mössbauer Resonance in $^{237}Np$—B. D. Dunlap, G. M. Kalvius, S. L. Ruby, M. B. Brodsky, and D. Cohen. 171, 316 (1968)

COHEN, E.
Vibronic Transitions of $Sm^{2+}$ and $Eu^{2+}$ in $SrF_2$ and their Zeeman Effect—E. Cohen and H. J. Guggenheim. 175, 354 (1968)
Effective Density of Phonon States for $NdCl_3$ from Vibronic Spectra and Applications to Ion-Lattice Interactions—E. Cohen, L. A. Riseberg, and H. W. Moos. 175, 521 (1968)

COHEN, E. G. D.
Phase Separation in Isotopic Fermi-Bose Mixtures—J. M. J. van Leeuwen and E. G. D. Cohen. 176, 385 (1968)

COHEN, Jeffrey M.
Gravitational Collapse of Rotating Bodies—Jeffrey M. Cohen. 173, 1258 (1968)

COHEN, K. J.
Wide-Angle Electron-Positron Pair Production. K. J. Cohen, S. Homma, D. Luckey, and L. S. Osborne. 173, 1339 (1968)

COHEN, Marvin L.
Meson Captures in Solids—M. Y. Au-Yang and Marvin L. Cohen. 174, 468 (1968)

COHEN, Morrel H.
Vibrational Modes of a Negative Ion in Liquid Helium—V. Celli, Morrel H. Cohen, and M. J. Zuckerman. 173, 253 (1968)

COHEN, R. L.
Hyperfine Structure of $Au^{197}$ in Fe Measured with the Mössbauer Effect—R. L. Cohen. 171, 343 (1968)

COHEN, Roger W.
Microwave Properties of Granular Superconductors—Roger W. Cohen and J. I. Gittleman. 176, 500 (1968)

COHEN, S. L.
Self-Consistent Calculation of Vector- and Pseudoscalar-Meson Mass Splittings—S. L. Cohen. 174, 1867 (1968)

COLEMAN, M. G.
Isotope Effect for Diffusion of Iron in Vanadium—M. G. Coleman, C. A. Wert, and R. F. Peart. 175, 788 (1968)

COLEMAN, R. V.
Experiments with Tunnel Junctions Using Ferromagnetic Metals—J. E. Christopher, R. V. Coleman, Acar Isin, and R. C. Morris. 172, 485 (1968)

COLEMAN, Sidney
Origin of "Hidden Momentum Forces" on Magnets—Sidney Coleman and J. H. Van Vleck. 171, 1370 (1968)

COLLIGAN, M. B.
Noise Properties of n-Type Gold-Doped Silicon—M. B. Colligan and K. M. van Vliet. 171, 881 (1968)

COLLINS, A. T.
Photothermal Ionization and Photon-Induced Tunneling in the Acceptor Photoconductivity Spectrum of Semiconducting Diamond—A. T. Collins and E. C. Lightowlers. 171, 843 (1968)

COLLINS, C. B.
Calculation of the Dependence of Emitted Light on Charge Density for Two-Electron Collisional-Radiative Recombination in the Hydrogenic Approximation—C. B. Collins. 175, 160 (1968)

COLLINS, P. D. B.
Argand-Diagram Loops and Regge Poles—P. D. B. Collins, R. C. Johnson, and G. G. Ross. 176, 1952 (1968)

COLLINS, T. C.
Excited States of Bound Exciton Complexes in CdS—D. C. Reynolds, C. W. Litton, and T. C. Collins. 174, 845 (1968)

COMPTON, W. Dale
Luminescent Excitation Spectra of *F* and *M* Centers in KCl—James L. Boettler and W. Dale Compton. 173, 844 (1968)
Recombination Luminescence in Irradiated Silicon—Robert J. Spry and W. Dale Compton. 175, 1010 (1968)

CONDON, P.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)

CONGEL, F. J.
Relativistic Energy Loss by Ionization in Nuclear Emulsions—F. J. Congel and P. J. McNulty. 176, 1615 (1968)

CONLEY, J. W.
Erratum: Electron Tunneling in Metal-Semiconductor Barriers—J. W. Conley, C. B. Duke, G. D. Mahan, and J. J. Tiemann. [150, 466 (1966)] 174, 1082 (1968)

CONTOGOURIS, A.P.
Factorization and Constraints in Regge-Pole Theory—A. Capella, A. P. Contogouris, and J. Tran Thanh Van. 175, 1892 (1968)

CONZETT, H. E.
Proton-Proton Elastic Scattering between 6 and 10 MeV—R. J. Slobodrian, H. E. Conzett, E. Shield, and W. F. Tivol. 174, 1122 (1968)

COOK, C. J.
Pion Double-Charge-Exchange Cross-Section Measurements—C. J. Cook, M. E. Nordberg, Jr., and R. L. Burman. 174, 1374 (1968)

COOK, Earl L.
Kinetics of Oxide Film Growth on Metal Crystals: Electronic and Ionic Diffusion in Large Surface-Charge and Space-Charge Fields—A. T. Fromhold, Jr., and Earl L. Cook. 175, 877 (1968)

COOK, L. F.
Pion Form-Factor Zero and "Dipole" Nucleon Structure—J. J. Brehm and L. F. Cook. 174, 1901 (1968)
Splitting, Mixing, and Small Perturbations in $SU(3)$ Multiplets of Vector Mesons—L. F. Cook and H. L. Watson. 174, 2113 (1968)

COOKE, James H.
Interaction Angular Momentum—James H. Cooke. 174, 1602 (1968)

COOPER, Bernard R.
Collective Excitations and Magnetic Ordering in Materials with Singlet Crystal-Field Ground State—Yung-Li Wang and Bernard R. Cooper. 172, 539 (1968)

COOPER, Martin J.
Generalized Scaling and the Critical Eigenvector in Ideal Bose Condensation—Martin J. Cooper and Melville S. Green. 176, 302 (1968)

COPPERSMITH, Michael H.
Analytic Free Energy: A Basis for Scaling Laws—Michael H. Coppersmith. 172, 230 (1968)

CORBETT, I. F.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

CORELLI, J. C.
Photoconductivity Studies of Defects in Silicon: Divacancy-Associated Energy Levels—A. H. Kalma and J. C. Corelli. 173, 734 (1968)

CORNWALL, John M.
Current Commutators and Electromagnetic Mass Differences—John M. Cornwall and R. E. Norton. 173, 1637 (1968)

CORRIGAN, Dennis
High-Energy Proton-Proton Scattering and Nucleon Structure: The Scalar Interaction in $O(4,2)$—A. O. Barut and Dennis Corrigan. 172, 1593 (1968)

COSENS, B. L.
Remeasurement of the Lamb Shift in D, $n$=2—B. L. Cosens. 173, 49 (1968)

COSMAN, E. R.
Nuclear-Reaction Studies in the Strontium Isotopes: Neutron Particle-Hole States in $Sr^{88}$ and the $Sr^{87}(d,p)Sr^{88}$ Reaction—E. R. Cosman and D. C. Slater. 172, 1126 (1968)

COSPER, S. W.
Observation of the Lowest $p$-Shell $T=\frac{3}{2}$ States of $^{11}B$ and $^{11}C$—S. W. Cosper, Robert L. McGrath, Joseph Cerny, Creve C. Maples, George W. Goth, and Donald G. Fleming. 176, 1113 (1968)

COSSLETT, S. R.
Kinematic Singularity Structure of Amplitudes for a Four-Particle Process with One Massless Particle—S. R. Casslett. 176, 1782 (1968)

COTÉ, R. E.
Study of the $Nb^{93}(\pi_{res},\gamma)Nb^{94}$ Reaction—W. V. Prestwich, R. E. Coté, and Hla Shwe. 174, 1421 (1968)
Neutron Resonances of $Th^{230}$—R. E. Coté, H. Diamond, J. E. Gindler, and Hla Shwe. 176, 1421 (1968)

COTIGNOLA, J. M.
Thermal and Electrical Conductivities of Very-High-Purity Indium—M. E. de la Cruz, F. de la Cruz, J. M. Cotignola, O. J. Bressan, and C. A. Luengo. 176, 871 (1968)

COX, J.
Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)

COX, R. S.
Collective Effects in the $P^{31}(He^3,p)S^{33}$ Reaction—R. S. Cox, R. W. West, and R. J. Ascuitto. 175, 1419 (1968)

CRAIG, Paul P.
Correlation between Mössbauer Resonance Strength and Second-Order Doppler Shift: Estimate of Zero-Point Velocity—R. Dean Taylor and Paul P. Craig. 175, 782 (1968)

CRAPO, Lawrence M.
Nuclear Radio-Frequency Spectra of a Series of Tetrahedral Molecules—Irving Ozier, Lawrence M. Crapo, and Sang Soo Lee. 172, 63 (1968)

CRASEMANN, Bernd
Total Internal Conversion Coefficient of the 23.9-keV Ground-State Transition in $^{119m}Sn$—Vaclav O. Koustroun and Bernd Crasemann. 174, 1535 (1968)

CRAWLEY, G. M.
$^6Li(p,p)^6Li$(3.56 MeV) Reaction from $E_p$=24.3 to 46.4 MeV and the Effective Interaction—S. M. Austin, P. J. Locard, W. Benenson, and G. M. Crawley. 176, 1227 (1968)

CRESPO, V. P.
Fission of $U^{238}$ by 2.2-GeV Protons—V. P. Crespo, J. B. Cumming, and A. M. Poskanzer. 174, 1455 (1968)

CREVELING, L., Jr.
Magnetic Properties of Gold-Rich Gold-Vanadium Alloys—L. Creveling, Jr., and H. L. Luo. 176, 614 (1968)

CROSS, L. E.
Pressure and Temperature Dependence of the Dielectric Properties of the Perovskite Barium Titanate—A. K. Goswami and L. E. Cross. 171, 549 (1968)

CROSSMAN, L. D.
Piezoresistance of $n$-Type Magnesium Stannide—L. D. Crossman and G. C. Danielson. 171, 867 (1968)

CROSSWHITE, Hannah
Magnetic Parameters for the Configuration $f^3$—Hannah Crosswhite, H. M. Crosswhite, and B. R. Judd. 174, 89 (1968)

CROSSWHITE, H. M.
Magnetic Parameters for the Configuration $f^3$—Hannah Crosswhite, H. M. Crosswhite, and B. R. Judd. 174, 89 (1968)

CROWELL, Julian
Radiative Decay of Coulomb-Stimulated Plasmons in Spheres—Julian Crowell and R. H. Ritchie. 172, 436 (1968)

CUE, N.
Proton Decay of Analog States Formed in the $(d,n)$ Reaction—N. Cue and Patrick Richard. 173, 1108 (1968)

CÜER, P.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)

Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/$c$—A. Fridman, G. Maurer, A. Michalon, J. Oudet, R. Straub, C. Voltolini, and P. Cüer. 176, 1595 (1968)

CULLIGAN, G.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)

Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

CUMMING, J. B.
Fission of $U^{238}$ by 2.2-GeV Protons—V. P. Crespo, J. B. Cumming, and A. M. Poskanzer. 174, 1455 (1968)

CUMMINS, Herman Z.
Thermal Diffusivity of $CO_2$ in the Critical Region—H. L. Swinney and Herman Z. Cummins. 171, 152 (1968)

CUPP, R. E.
Hyperfine Structure in the Millimeter Spectrum of Hydrogen Sulfide: Electric Resonance Spectroscopy on Asymmetric-Top Molecules—R. E. Cupp, R. A. Kempf, and J. J. Gallagher. 171, 60 (1968)

CURRY, J. R.
$^{31}P(d,\alpha)^{29}Si$ Reaction from 7.3 to 12.0 MeV—G. A. Lock, J. R. Curry, P. J. Riley, and C. G. Shugart. 176, 1293 (1968)

CURTIS, O. L., Jr.
Steady-State Photoconductivity in the Presence of Traps—O. L. Curtis, Jr. 172, 773 (1968)

CUTHILL, J. R.
Search for Plasmaron Structure in the Soft X-Ray $L_{2,3}$ Emission Spectrum of Al—J. R. Cuthill, R. C. Dobbyn, A. J. McAlister, and M. L. Williams. 174, 515 (1968)

CUTKOSKY, R. E.
Optimized Polynomial Expansion for Scattering Amplitudes—R. E. Cutkosky and B. B. Deo. 174, 1859 (1968)

CUTLER, Melvin
Erratum: Electric Properties of $n$-Type Liquid Alloys of Thallium and Tellurium—Melvin Cutler and Marshall B. Field. [169, 632 (1968)] 174, 1082 (1968)

Hall Measurements in Liquid Thallium-Tellurium—James M. Donally and Melvin Cutler. 176, 1003 (1968)

CZJZEK, Gordon
Coulomb-Recoil-Implantation Mössbauer Experiments with $^{73}Ge$—Gordon Czjzek, J. L. C. Ford, Jr., John C. Love, Felix E. Obenshain, and Horst H. F. Wegener. 174, 331 (1968)

DALGARNO, A.
Properties of the Lithium Sequence—A. Dalgarno and E. M. Parkinson. 176, 73 (1968)

Nonadiabatic Long-Range Forces—A. Dalgarno, G. W. F. Drake, and G. A. Victor. 176, 194 (1968)

DALTON, Bryan J.
Angular Distribution of Molecular Photoelectrons—John C. Tully, R. Stephen Berry and Bryan J. Dalton. 176, 95 (1968)

DALY, Daniel F.
Electron-Nuclear Double-Resonance Spectrum of the $V_K$ Center in Sodium Fluoride—Daniel F. Daly and Robert Lee Mieher. 175, 412 (1968)

DAMON, D. H.
Phonon-Assisted Impurity Scattering in Gold Alloys—D. H. Damon, M. P. Mathur, and P. G. Klemens. 176, 876 (1968)

DANDEKAR, Dattatraya P.
Pressure Dependence of the Elastic Constants of Calcite—Dattatraya P. Dandekar. 172, 873 (1968)

DANIELS, W. R.
Beta Decay of $^{144}Ce$—D. C. Hoffman, F. O. Lawrence, and W. R. Daniels. 172, 1239 (1968)

DANIELSON, G. C.
Piezoresistance of $n$-Type Magnesium Stannide—L. D. Crossman and G. C. Danielson. 171, 867 (1968)

DAS, T. P.
Zero-Field Splitting of $S$-State Ions. III. Corrections to Parts I and II and Application to Distorted Cubic Crystals—R. R. Sharma, T. P. Das, and R. Orbach. 171, 378 (1968)

Many-Body Approach to the Atomic Hyperfine Problem. I. Lithium-Atom Ground State—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 1 (1968)

Many-Body Calculation of Atomic Polarizability—Relation to Hartree-Fock Theory—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 16 (1968)

Short-Range Effects on the Pressure Shift for a Nitrogen Atom in a Rare-Gas Atmosphere—Supriya Ray and T. P. Das. 174, 32 (1968)

Hyperfine Pressure Shift and van der Waals Interaction. I. Hydrogen-Helium System—Supriya Ray, J. D. Lyons, and T. P. Das. 174, 104 (1968)

Hyperfine Pressure Shift and van der Waals Interaction. II. Nitrogen-Helium System—J. D. Lyons, Supriya Ray, and T. P. Das. 174, 112 (1968)

Theoretical Analysis of the Hyperfine Structure of Alkali Atoms—L. Tterlikkis, S. D. Mahanti, and T. P. Das. 176, 10 (1968)

DASANNACHARYA, B. A.
Neutron Diffraction by Liquid Zinc—B. A. Dasannacharya, Q. O. Navarro, H. Ibarra, S. Chatraphorn, and G. B. Lee. 173, 241 (1968)

DASGUPTA, B.
Conductivity of a Plasma in a Steady Magnetic Field. II—T. Pradhan and B. Dasgupta. 176, 309 (1968)

DAS GUPTA, S.
Moment of Inertia in Light Nuclei—S. Das Gupta and A. Van Ginneken. 174, 1316 (1968)

DAS GUPTA, Sutapa
Consequences of a $QQ\bar{Q}$ Model for Meson-Baryon Processes—S. Das Gupta, V. K. Gupta, and A. N. Mitra. 172, 1482 (1968)

Three-Particle Final States in the Quark Model—Sutapa Das Gupta. 173, 1745 (1968)

DASH, J. G.
Low-Temperature Anharmonicity in $FeCl_2$—D. P. Johnson and J. G. Dash. 172, 983 (1968)
Statistical Mechanics of Monolayers of Bose and Fermi Atoms Adsorbed on Crystalline Surfaces—J. G. Dash and Michael Bretz. 174, 247 (1968)

DASH, Jan W.
Pion Photoproduction, *NN* Scattering, and Photoproduction Sum Rules—Richard C. Brower and Jan W. Dash. 175, 2014 (1968)

DASS, Guru Vachan
Regge Poles and Finite-Energy Sum Rules for Kaon-Nucleon Scattering—Guru Vachan Dass and C. Michael. 175, 1774 (1968)

DATARS, W. R.
Azbel'-Kaner Cyclotron Resonance in Mercury—A. E. Dixon and W. R. Datars. 175, 928 (1968)

DATE, S. K.
Mössbauer Effect for $Fe^{57}$ in $Al_2O_3$—Effects of Variety of Heat Treatments—V. G. Bhide and S. K. Date. 172, 345 (1968)

DATTA, K.
Current Algebra, Crossing Symmetry, and Unitarity for $s$-Wave $\pi\pi$ Scattering—K. Datta, K. C. Gupta, and V. S. Varma. 173, 1549 (1968)
Complex $\bar{K}N$ Scattering Lengths and Current Algebra—Debabrata Basu, S. N. Biswas, and K. Datta. 176, 1835 (1968)

DATZ, S.
Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10-180 MeV—C. D. Moak, H. O. Lutz, L. B. Bridwell, L. C. Northcliffe, and S. Datz. 176, 427 (1968)

D'AURIA, J. M.
Deformation in the Light Ba Isotopes: Isomeric States of $Ba^{125}$ and $Ba^{127}$—J. M. D'Auria, H. Bakhru, and I. L. Preiss. 172, 1176 (1968)
Study of the Particles Emitted from $Br^{75}$ Compound Nuclei Formed in Two Ways: $C^{12}+Cu^{63}$ and $O^{16}+Co^{59}$—J. M. D'Auria, M. J. Fluss, G. Herzog, L. Kowalski, J. M. Miller, and R. C. Reedy. 174, 1409 (1968)

DAVIDSON, E. R.
Application of Geminal Methods to Molecular Calculations—C. F. Bender, E. R. Davidson, and F. D. Peat. 174, 75 (1968)

DAVIDSON, J.P.
Symmetric-Core Collective Model for Odd-Odd Nuclei with Applications in the $2s$-$1d$ Shell—R. J. Ascuitto, D. A. Bell, and J. P. Davidson. 176, 1323 (1968)

DAVIDSON, R. C.
Resonant Four-Wave Interaction of Electron-Plasma Oscillations—R. C. Davidson. 176, 344 (1968)

DAVIES, B.
Correlation Function in a Plasma at Zero Particle Separation—B. Davies and R. G. Storer. 171, 150 (1968)

DAVIS, H. L.
Specific Heat of Uranium Mononitride from 1.3 to 4.6°K—J. O. Scarbrough, H. L. Davis, W. Fulkerson, and J. O. Betterton, Jr. 176, 666 (1968)

DAVIS, L. C.
Electron and Phonon Tunneling Spectroscopy in Metal-Germanium Contacts—F. Steinrisser, L. C. Davis, and C. B. Duke. 176, 912 (1968)

DAVIS, R. H.
Optical-Model Analysis of Alpha-Particle Scattering by $^{40}Ca$ from 12 to 18 MeV—C. P. Robinson, J. P. Aldridge, Joseph John, and R. H. Davis. 171, 1241 (1968)

DAVISON, S. G.
Ionic Surface States from a Band-Edge Method—Jules D. Levine and S. G. Davison. 174, 911 (1968)

DAVISON, Tollie
Variance of $H$ in the Bijl-Feynman Description of an Elementary Excitation—Tollie Davison and Eugene Feenberg. 171, 221 (1968)

DAWSON, W. K.
Determination of Total Widths and Resonance Energies of the Single-Particle Analog Resonances in $^{209}Bi$—W. R. Wharton, P. von Brentano, W. K. Dawson, and Patrick Richard. 176, 1424 (1968)

DAYAL, Yogeshwar
Effect of Ion Bombardment on the Electrical Conductivity of Germanium—William Primak and Yogeshwar Dayal. 175, 1033 (1968)

DEAN, P. J.
Concentration Quenching of Luminescence by Donors or Acceptors in Gallium Phosphide and the Impurity-Band Auger Model—J. C. Tsang, P. J. Dean, and P. T. Landsberg. 173, 814 (1968)
Electron-Capture ("Internal") Luminescence from the Oxygen Donor in Gallium Phosphide—P. J. Dean and C. H. Henry. 176, 928 (1968)

DeANGELIS, Henry M.
Energy Dependence of Damage Recovery in $n$-Type Ge Electron-Irradiated at 4.2°K—Rudolf E. Penczer and Henry M. DeAngelis. 171, 862 (1968)

DE BAENST, P.
Determination of the Electromagnetic Couplings of the $\rho$ and $A_1$ Mesons—P. De Baenst and J. Pestieau. 171, 1805 (1968)

DE BROGLIE, Louis
Interpretation of a Recent Experiment on Interference of Photon Beams—Louis de Broglie and J. Andrade e Silva. 172, 1284 (1968)

DECK, R. T.
$W^+$-Meson Production—W. Williamson, Jr., and R. T. Deck. 174, 1986 (1968)

DECKER, D. L.
Mössbauer-Effect Measurements in Iron at High Pressures—W. H. Southwell, D. L. Decker, and H. B. Vanfleet. 171, 354 (1968)
Neutron Diffraction Study of the Magnetic Structure of Hematite to 41 kbar—T. G. Worlton and D. L. Decker. 171, 596 (1968)

DECKER, W. R.
Critical-Field Curves for Gapless Superconductors—W. R. Decker and D. K. Finnemore. 172, 430 (1968)

DEEGAN, R. A.
Structure Dependence of $d$ Bands in Transition Metals—R. A. Deegan. 171, 659 (1968)

DEERING, W. D.
Size Effect in Electrical Conductivity of Metallic Films with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey, J. R. Sybert, and W. D. Deering. 175, 729 (1968)
Size Effect in the Electrical Conductivity of Cylindrical Wires—H. J. Mackey, W. D. Deering, and J. R. Sybert. 176, 856 (1968)

DEHNE, H. C.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)

DE LA CRUZ, F.
Thermal and Electrical Conductivities of Very-High-Purity Indium—M. E. de la Cruz, F. de la Cruz, J. M. Cotignola, O. J. Bressan, and C. A. Luengo. 176, 871 (1968)

DE LA CRUZ, M. E.
**Thermal and Electrical Conductivities of Very-High-Purity Indium**—M. E. de la Cruz, F. de la Cruz, J. M. Cotignola, O. J. Bressan, and C. A. Luengo. 176, 871 (1968)

DELANEY, Robert M.
Relation of Charged-$K$ Decay to $CP$ Violation—Robert M. Delaney and Daniel J. Welling. 176, 1841 (1968)

DELBOURGO, R.
Reggeization of Quark Number—R. Delbourgo, Abdus Salam, and J. Strathdee. 172, 1727 (1968)
**Meson-Baryon and Baryon-Baryon Scattering in Reggeized $U(6)\otimes U(6)$ Theory**—R. Delbourgo and Harun-ar Rashid. 176, 2074 (1968)

DEL CASTILLO, G.
**Magnetic Flux Penetration in Type-II Superconductors. I**—G. del Castillo and R. W. Fast. 175, 575 (1968)

DEL RE, Giuseppe
Correlation Coefficients for Electronic Wave Functions—Werner Kutzelnigg, Giuseppe Del Re, and Gaston Berthier. 172, 49 (1968)

DELTOUR, R.
Coupled Motion of Vortices in Superposed Superconducting Films—R. Deltour and M. Tinkham. 174, 478 (1968)

DELUCCHI, A. A.
**Cumulative Fission Yield and Half-Life of $^{134}$Sb**—A. A. Delucchi, A. E. Greendale, and P. O. Strom. 173, 1159 (1968)

DeMARTINI, D. C.
Polarization of the Neutrons from the $^{12}C(d,n)^{13}N$ Reaction at the 4-MeV Resonance and between 5.2 and 6.2 MeV—T. R. Donoghue, W. L. Baker, P. L. Beach, D. C. DeMartini, and C. R. Soltesz. 173, 952 (1968)

DE MICHELIS, B.
Erratum: Electron Longitudinal Depolarization with Great Energy Loss—L. Braicovich, B. De Michelis, and A. Fasana. [164, 1360 (1967)] 171, 1330 (1968)
Scattering of $\beta$ Radiation on a Thick Foil: Production of Transverse Polarization—L. Braicovich, B. De Michelis, and A. Fasana. 174, 460 (1968)

DENARIEZ, Marguerite
Investigation of Rayleigh Wings and Brillouin-Stimulated Scattering in Liquids—Marguerite Denariez and Georges Bret. 171, 160 (1968)

DENHAM, P.
Electric-Field Modulation of Luminescence-Excitation in Natural Diamond in the Spectral Energy Range 5.0–6.0 eV—P. Denham and E. C. Lightowlers. 174, 800 (1968)

DEO, B. B.
Optimized Polynomial Expansion for Scattering Amplitudes—R. E. Cutkosky and B. B. Deo. 174, 1859 (1968)

DePASQUALI, G.
**Effect of Pressure on $f$ Number and Isomer Shift for $Fe^{57}$ in Cu, V, and Ti**—J. A. Moyzis, Jr., G. DePasquali, and H. G. Drickamer. 172, 665 (1968)

DERADO, I.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

DE RAFAEL, E.
Calculation of the Sixth-Order Contribution from the Fourth-Order Vacuum Polarization to the Difference of the Anomalous Magnetic Moments of Muon and Electron—B. E. Lautrup and E. de Rafael. 174, 1835 (1968)

DESAI, Bipin R.
Pomeranchuk Theorem for Partial Waves and Narrowing of Resonance Widths: The $\rho$ Meson—Bipin R. Desai and David T. Gregorich. 173, 1434 (1968)

DESER, S.
Equal-Time Commutators and Electromagnetic Mass Splittings—David G. Boulware and S. Deser. 175, 1912 (1968)

DESLATTES, Richard D.
$L$-Series Emission Spectrum of Germanium—Richard D. Deslattes. 172, 625 (1968)

DEVLIN, Thomas J.
Double Charge Exchange of Positive $\pi$ Mesons on Complex Nuclei—P. E. Boynton, Thomas J. Devlin, J. Solomon, and V. Perez-Mendez. 174, 1083 (1968)

DE WAMES, Roger E.
Mass Dependence of the Angular Distribution of Charged-Particle Emission from Crystals: Transition to the Classical Limit—R. E. De Wames, W. F. Hall, and G. W. Lehman. 174, 392 (1968)
Magnetic Scattering of Electrons from Crystals and Polarization of the Scattered Beam—Lawrence A. Vredevoe and Roger E. De Wames. 176, 684 (1968)

DE WETTE, F. W.
Inelastic Scattering of Neutrons by Polycrystals—F. W. de Wette and Aneesur Rahman. 176, 784 (1968)

DeWITT, Bryce S.
Erratum: Quantum Theory of Gravity. I. The Canonical Theory—Bryce S. DeWitt. [160, 1113 (1967)] 171, 1834 (1968)
Erratum: Quantum Theory of Gravity. II. The Manifestly Covariant Theory—Bryce S. DeWitt. [162, 1195 (1967)] 171, 1834 (1968)
Erratum: Quantum Theory of Gravity. III. Applications of the Covariant Theory—Bryce S. DeWitt. [162, 1239 (1967)] 171, 1834 (1968)

DEXTER, D. L.
Electronic Bubble States in Liquid Helium—W. Beall Fowler and D. L. Dexter. 176, 337 (1968)

DE ZORZI, G.
Proton Compton Effect by Polarized Photons at 90° in the c.m. System in the First Resonance Region—G. Barbellini, G. Capon, G. De Zorzi, and G. P. Murtas. 174, 1665 (1968)

DHAR, J.
Quantum Field Theory of Interacting Tachyons—J. Dhar and E. C. G. Sudarshan. 174, 1808 (1968)

DIAMOND, H.
**Neutron Resonances of $Th^{230}$**—R. E. Coté, H. Diamond, J. E. Gindler, and Hla Shwe. 176, 1421 (1968)

DÍAZ, J.
**$pp$ Interactions at 10 GeV/$c$**—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)

DICK, C. E.
Inelastic Scattering Cross Sections for 200- and 400-keV Electrons—C. E. Dick and J. W. Motz. 171, 75 (1968)

DICKENS, J. K.
11-MeV Proton Optical-Model Analysis—C. M. Perey, F. G. Perey, J. K. Dickens, and R. J. Silva. 175, 1460 (1968)

DiDOMENICO, M.
Raman Spectrum of Single-Domain $BaTiO_3$—M. DiDomenico, Jr., S. H. Wemple, S. P. S. Porto, and R. P. Bauman. 174, 522 (1968)

DIEHL, R. C.
$s_{1/2}$-$h_{11/2}$ Anomaly in Stripping Studies near $A$=110—B. L. Cohen, R. A. Moyer, J. B. Moorhead, L. H. Goldman, and R. C. Diehl. 176, 1401 (1968)

DIENES, Andrew
Theory of Nonlinear Effects in a Gas Laser Amplifier. I. Weak Signals—Andrew Dienes. 174, 400 (1968)
Theory of Nonlinear Effects in a Gas Laser Amplifier. II. Strong Signals—Andrew Dienes. 174, 414 (1968)

DILLINGER, J. R.
Specific Heat of a Spherical Type-II Superconductor—Paul Zoller and J. R. Dillinger. 172, 390 (1968)

DIONNE, Gerald F.
Origin of the Crystal Field in $Ti^{3+}$-Substituted Alums—Gerald F. Dionne and John A. MacKinnon. 172, 325 (1968)

DITZENBERGER, J. A.
Long-Wavelength Optical Lattice Vibrations in Mixed $KMgF_3$-$KNiF_3$ Crystals—A. S. Barker, Jr., J. A. Ditzenberger, and H. J. Guggenheim. 175, 1180 (1968)

DIVGI, D. R.
Reanalysis of the Lowest-Mass Negative-Parity Baryon Resonances Using the Symmetric Quark Model—D. R. Divgi and O. W. Greenberg. 175, 2024 (1968)
Decays of Negative-Parity Baryons in a Quark Model—D. R. Divgi. 175, 2027 (1968)

DIXON, A. E.
Azbel'-Kaner Cyclotron Resonance in Mercury—A. E. Dixon and W. R. Datars. 175, 928 (1968)

DIXON, J. R.
Band Inversion and the Electrical Properties of $Pb_xSn_{1-x}Te$—J. R. Dixon and R. F. Bis. 176, 942 (1968)

DOBBYN, R. C.
Search for Plasmaron Structure in the Soft X-Ray $L_{2,3}$ Emission Spectrum of Al—J. R. Cuthill, R. C. Dobbyn, A. J. McAlister, and M. L. Williams. 174, 515 (1968)

DOBSON, Peter N., Jr.
Representation Mixing and $SU_3$ Symmetry Breaking in the $\frac{1}{2}^-$ Baryon Octet—Peter N. Dobson, Jr. 176, 1757 (1968)

DO DANG, Giu
Self-Consistent Theory of Nuclear Spectra: Pairing-Force Model—Giu Do Dang, R. M. Dreizler, Abraham Klein, and Chi-Shiang Wu. 172, 1022 (1968)

DOERING, John P.
Rotational Excitation in Ion-Molecule Collisions: The System $H_2^+ + N_2$—John H. Moore, Jr. and John P. Doering. 174, 178 (1968)

DOLAN, K.W.
Lifetime Measurements from the $K^{39}(p,\gamma)Ca^{40}$ Reaction—K. W. Dolan and D. K. McDaniels. 175, 1446 (1968)

DOMBEY, Norman
Weak $\eta$ Production and the Existence of Second-Class Currents—Norman Dombey. 174, 2127 (1968)

DONALDSON, R. E.
Measurement of the Coherent Neutron Scattering Amplitude of Deuterium, Mercury, and Fluorine by Mirror Reflection—W. Bartolini, R. E. Donaldson, and D. J. Groves. 174, 313 (1968)

DONALLY, James M.
Hall Measurements in Liquid Thallium-Tellurium—James M. Donally and Melvin Cutler. 176, 1003 (1968)

DONIACH, S.
Kondo Problem at Low Temperatures—S. Doniach. 173, 599 (1968)
Estimate of Damping of Short-Wave Magnons for a Heisenberg Ferromagnet below $T_C$—P. D. Loly and S. Doniach. 173, 603 (1968)

DONNACHIE, A.
Theoretical Study of $K_{l4}$ Decay—F. A. Berends, A. Donnachie, and G. C. Oades. 171, 1457 (1968)

DONNELLY, D. P.
High-Resolution Gamma-Ray Spectroscopic Study of the Decay $^{133}Ba \rightarrow {}^{133}Cs$—D. P. Donnelly, J. J. Reidy, and M. L. Wiedenbeck. 173, 1192 (1968)

DONOGHUE, T. R.
Polarization of the Neutrons from the $^{12}C(d,n)^{13}N$ Reaction at the 4-MeV Resonance and between 5.2 and 6.2 MeV—T. R. Donoghue, W. L. Baker, P. L. Beach, D. C. DeMartini, and C. R. Soltesz. 173, 952 (1968)

DONOHUE, R. J.
Measured Shifts of Cesium Atomic Lines—Correlation with Electron Density Derived from Widths—R. F. Majkowski and R. J. Donohue. 173, 177 (1968)

DONOVAN, T. M.
Erratum: Optical Properties of Cobalt—A. Y-C. Yu, T. M. Donovan, and W. E. Spicer. [167, 670 (1968)] 172, 1002 (1968)

DOOLEN, G.
Maximum Number of Binary Collisions for Three Relativistic Point Particles—G. Doolen. 176, 1541 (1968)

DORFMAN, J. R.
Some Remarks on Perturbation Theory and Critical Phenomena—P. T. Herman and J. R. Dorfman. 176, 295 (1968)

DOSCH, H. G.
Asymptotic Behavior of Amplitudes for Meson Photoproduction—H. G. Dosch. 173, 1595 (1968)

DOTCHIN, L. W.
Radiative Mean-Life Measurements of Some Atomic-Hydrogen Excited States Using Beam-Foil Excitation—E. L. Chupp, L. W. Dotchin, and D. J. Pegg. 175, 44 (1968)

DOUGHTY, B. M.
Electron Capture into the $n$=3 States of H by Fast $H^+$ Impact on $N_2$—R. H. Hughes, B. M. Doughty, and A. R. Filippelli. 173, 172 (1968)

DOUGLASS, R. L.
Mobility of Negative Ions Along Vortices in Rotating Superfluid Helium—R. L. Douglass. 174, 255 (1968)

DOW, John D.
Electron-Phonon Interactions in Solid Alkali Metals. I. Scattering and Transport Coefficients—John E. Robinson and John D. Dow. 171, 815 (1968)
Resonance Energy Transfer in Condensed Media from a Many-Particle Viewpoint—John D. Dow. 174, 962 (1968)

DRACHMAN, Richard J.
Possible Resonance in Positron-Hydrogen Scattering—Richard J. Drachman. 171, 110 (1968)
Variational Bounds in Positron-Atom Scattering—Richard J. Drachman. 173, 190 (1968)

DRAKE, C. W.
Parity Conservation in the Reaction $T(d,n)He^4$—D. C. Bonar, C. W. Drake, R. D. Headrick, and V. W. Hughes. 174, 1200 (1968)

DRAKE, G. W. F.
Nonadiabatic Long-Range Forces—A. Dalgarno, G. W. F. Drake, and G. A. Victor. 176, 194 (1968)

DRALLE, A.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

DREIZLER, R. M.
Concept of Ideal Collective Coordinate as the Foundation for a Phenomenological Theory of Nuclear Collective Motion: Basic Ideas and Relation to Other Phenomenological Methods—Abraham Klein, R. M. Dreizler, and Robert E. Johnson. 171, 1216 (1968)
Self-Consistent Theory of Nuclear Spectra: Pairing-Force Model—Giu Do Dang, R. M. Dreizler, Abraham Klein, and Chi-Shiang Wu. 172, 1022 (1968)

DRICKAMER, H. G.
Effect of Pressure on the Isomer Shift of $Fe^{57}$ in the bcc Phase—J. A. Moyzis, Jr., and H. G. Drickamer. 171, 389 (1968)
Effect of Pressure on *f* Number and Isomer Shift for $Fe^{57}$ in Cu, V, and Ti—J. A. Moyzis, Jr., G. DePasquali, and H. G. Drickamer. 172, 665 (1968)
DRICKEY, D. J.
Charged Component of 1-GeV Electron Showers in Lead—D. J. Drickey, J. R. Kilner, and D. Benaksas. 171, 310 (1968)
DRUMMOND, I. T.
Multi-Reggeon Behavior of Production Amplitudes—I. T. Drummond. 176, 2003 (1968)
DUFTY, James W.
Correlation Functions as Hydrodynamic Green's Functions—James W. Dufty and James A. McLennan. 172, 176 (1968)
Hydrodynamics and Time-Correlation Functions—James W. Dufty. 176, 398 (1968)
DUGAN, A. E.
Defect Energy-Level Structure of $PbI_2$ Single Crystals—A. E. Dugan and H. K. Henisch. 171, 1047 (1968)
DUKE, C. B.
Erratum: Electron Tunneling in Metal-Semiconductor Barriers—J. W. Conley, C. B. Duke, G. D. Mahan, and J. J. Tiemann. [150, 466 (1966)] 174, 1082 (1968)
Electron and Phonon Tunneling Spectroscopy in Metal-Germanium Contacts—F. Steinrisser, L. C. Davis, and C. B. Duke. 176, 912 (1968)
Theory of the Tunneling Spectroscopy of Collective Excitations—Alan J. Bennett, C. B. Duke, and S. D. Silverstein. 176, 969 (1968)
DUKE, C. L.
Total Internal-Conversion Coefficients for Low-Energy *E*2 Transitions in $Ra^{224}$, $Th^{228}$, $U^{234}$, $U^{236}$, and $Pu^{240}$—C. L. Duke and W. L. Talbert, Jr. 173, 1125 (1968)
DUNLAP, B. D.
Isomer Shift and Hyperfine Splittings of the 59.6-keV Mössbauer Resonance in $^{237}Np$—B. D. Dunlap, G. M. Kalvius, S. L. Ruby, M. B. Brodsky, and D. Cohen. 171, 316 (1968)
DUNN, Dennis
Urbach's Rule in an Electron-Phonon Model—Dennis Dunn. 174, 855 (1968)
DUNN, Gordon H.
Photodissociation of $H_2^+$ and $D_2^+$: Theory—Gordon H. Dunn. 172, 1 (1968)
DUNN, Tucson
A Parametric Approach to the Ground-State Energy of an Electron Gas—M. S. Becker, A. A. Broyles, and Tucson Dunn. 175, 224 (1968)
DUNNING, J. R., Jr.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)
DURGAPAL, M. C.
Exact Internal Solutions for Dense Massive Stars—M. C. Durgapal and G. L. Gehlot. 172, 1308 (1968)
DUTHIE, J. G.
Search for Cosmic Gamma Radiation in the Southern Sky—J. G. Duthie and R. W. Osborn. 176, 1505 (1968)
DUTT, G. C.
Measurements and Analyses of the $d_{5/2}$ Analog Resonance in the $^{88}Sr(p,n)^{88}Y$ Reaction—G. C. Dutt and R. Schrils. 175, 1413 (1968)
$2^-$ Isobaric Analog Resonance in the $^{89}Y(p,n_2)^{89}Zr$ Reaction and the Excited States of $^{89}Zr$—G. C. Dutt, F. Gabbard, J. J. Egan, and J. E. Wiest. 176, 1289 (1968)
DUTT, Ranabir
Momentum-Dependent $K_{e4}$-Decay Form Factors—Ranabir Dutt, K. C. Gupta, and J. S. Vaishya. 175, 1884 (1968)
DUTTA-ROY, Binayak
Scalar Nonet, Semileptonic *K* Decays, and Spectral-Function Sum Rules—Binayak Dutta-Roy and Alexander Martin. 176, 1979 (1968)
DWORZECKA, Maria
Binding Energies of Open-Shell Nuclei—Maria Dworzecka and Chindhu S. Warke. 175, 1346 (1968)
DYNES, R. C.
Superconductivity in Simple Metals—J. P. Carbotte and R. C. Dynes. 172, 476 (1968)
Phonon-Limited Ressistivity of Some Simple Metals—R. C. Dynes and J. P. Carbotte. 175, 913 (1968)
EBERLY, Joseph H.
Trajectory and Mass Shift of a Classical Electron in a Radiation Pulse—Joseph H. Eberly and Arthur Sleeper. 176, 1570 (1968)
EBNER, C.
Phonon-Quasiparticle Interactions in Dilute Solutions of $He^3$ in Superfluid $He^4$: III. Attenuation of First Sound Above 0.2°K—Gordon Baym, W. F. Saam, and C. Ebner. 173, 306 (1968)
EDEN, R. C.
Location of the $L_1$ and $X_3$ Minima in GaAs as Determined by Photoemission Studies—L. W. James, R. C. Eden, J. L. Moll, and W. E. Spicer. 174, 909 (1968)
EDEN, Richard J.
Phase Contours of Scattering Amplitudes. III. High Energy Behavior at Fixed Angles—Richard J. Eden and Chung-I Tan. 172, 1583 (1968)
EDWARDS, L. Roger
Transport Properties of Thulium Single Crystals—L. Roger Edwards and Sam Legvold. 176, 753 (1968)
EDWARDS, T. W.
Quasars and Quarks—J. C. Huang and T. W. Edwards. 171, 1331 (1968)
EGAN, J. J.
$2^-$ Isobaric Analog Resonance in the $^{89}Y(p,n_2)^{89}Zr$ Reaction and the Excited States of $^{89}Zr$—G. C. Dutt, F. Gabbard, J. J. Egan, and J. E. Wiest. 176, 1289 (1968)
EHLERS, Vernon J.
Hyperfine Structure of $^{67}Ga$ and $^{72}Ga$—Vernon J. Ehlers, Yurdanur Kabasakal, Howard A. Shugart, and Orhan Tezer. 176, 25 (1968)
EHRENREICH, H.
Assumption-Independent Single-Particle Wave Function for Positrons in Solids: Applications to Angular Distributions in Al and Si—D. Stroud and H. Ehrenreich. 171, 399 (1968)
Single-Site Approximations in the Electronic Theory of Simple Binary Alloys—B. Velický, S. Kirkpatrick, and H. Ehrenreich. 175, 747 (1968)
EHRHARDT, H.
Resonance Scattering of Slow Electrons from $H_2$ and CO Angular Distributions—H. Ehrhardt, L. Langhans, F. Linder, and H. S. Taylor. 173, 222 (1968)

EHRLICH, R. D.
Precise Muonic Kα Isotope Shifts for Nuclides from Si to Sn —R. D. Ehrlich. 173, 1088 (1968)
EICK, R. H.
Dispersion in the Nonlinear Susceptibility of GaP near the Reststrahl Band—W. L. Faust, C. H. Henry, and R. H. Eick. 173, 781 (1968)
EISENBERG, Y.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/c—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)
EISNER, R. L.
Compilation of $\pi^- p$ Data at 4 GeV/c: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)
EJIRI, Hiroyasu
Hindrance Factors for Beta Decays of Heavy Nuclei—Hiroyasu Ejiri, Kiyomi Ikeda, and Jun-Ichi Fujita. 176, 1277 (1968)
ELBAUM, C.
Electronic Energy States of Dislocations in CdS-Type Semiconductors—R. R. Holmes and C. Elbaum. 173, 803 (1968)
ELHOSHY, Ahmed H.
Periodic Dependence of the Electronic Stopping Cross Section for Energetic Heavy Ions in Solids—Ahmed H. Elhoshy and James F. Gibbons. 173, 454 (1968)
ELIAS, D. K.
Broken-Symmetry Model of Meson Interactions—L. A. Copley, D. K. Elias, and D. Masson. 173, 1552 (1968)
ELKIN, Edward L.
Defects in Irradiated Silicon: Electron Paramagnetic Resonance and Electron-Nuclear Double Resonance of the Arsenic- and Antimony-Vacancy Pairs—Edward L. Elkin and G. D. Watkins. 174, 881 (1968)
ELKOMOSS, S. O.
Energy Distribution Function for Helium—S. O. Elkomoss. 172, 153 (1968)
ELLIS, D. E.
Theory of Transition-Metal Complexes: Unrestricted Hartree-Fock Molecular-Orbital Method and Its Application to $KNiF_3$—D. E. Ellis, A. J. Freeman, and P. Ros. 176, 688 (1968)
ELLIS, R.
Measurement of Volume Recombination Coefficients in Highly Ionized Alkali Plasmas—S. von Goeler, R. W. Motley, and R. Ellis. 172, 162 (1968)
ELLISON, G. W.
$T$=0, $J$=0 Pion-Pion Interaction—G. W. Ellison and S. Humble. 173, 1563 (1968)
ELWYN, A. J.
Small-Angle Scattering of Neutrons by Heavy Nuclei—F. T. Kuchnir, A. J. Elwyn, J. E. Monahan, A. Langsdorf, Jr., and F. P. Mooring. 176, 1405 (1968)
ELZIE, J. L.
Identification and Yield of 5.0-sec $^{117}$Pd in the Thermal-Neutron Fission of $^{235}$U—H. V. Weiss, J. L. Elzie, and J. M. Fresco. 172, 1269 (1968)
EMERY, V. J.
Solution of Boltzmann Equation for Degenerate Fermi Systems—V. J. Emery. 175, 251 (1968)
EMMERSON, J. McL.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)
ENGELKEMEIR, D.
Alpha Decay of $^{243}$Am—J. R. Van Hise and D. Engelkemeir. 171, 1325 (1968)
ENGELMANN, R.
Study of the $\Lambda$-$N$ System in Low-Energy $\Lambda$-$p$ Elastic Scattering—G. Alexander, U. Karshon, A. Shapira, G. Yekutieli, R. Engelmann, H. Filthuth, and W. Lughofer. 173, 1452 (1968)
ENGELS, J.
Pion Photoproduction and Fixed-$t$ Dispersion Relations—J. Engels, A. Müllensiefen, and W. Schmidt. 175, 1951 (1968)
ENGLER, A.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)
ENSBERG, E. S.
Measurements of $g_J$ Ratios for $Rb^{85}$, $Rb^{87}$, Hydrogen, and Deuterium, and of the Hyperfine Separation of Deuterium—G. S. Hayne, E. S. Ensberg, and H. G. Robinson. 171, 20 (1968)
EPSTEIN, A.
Magnetic Structure of $NaNiF_3$—A. Epstein, J. Makovsky, M. Melamud, and H. Shaked. 174, 560 (1968)
EPSTEIN, Gary
Crossing-Symmetric Rising Regge Trajectories—Shu-Yuan Chu, Gary Epstein, Peter E. Kaus, Richard C. Slansky, and Fredrik Zachariasen. 175, 2098 (1968)
EPSTEIN, Martin
$Be^9(p,p\alpha)He^5$ Reaction at 57 MeV—P. G. Roos, H. G. Pugh, Mahavir Jain, H. D. Holmgren, Martin Epstein, and C. A. Ludemann. 176, 1246 (1968)
ERKELENZ, K.
Soft-Core Hamada-Johnston Nucleon-Nucleon Potential—E. Rochleder and K. Erkelenz. 172, 1013 (1968)
ERMA, Victorr A.
An Exact Solution for the Scattering of Electromagnetic Waves from Conductors of Arbitrary Shape. I. Case of Cylindrical Symmetry—Victorr A. Erma. 173, 1243 (1968)
Exact Solution for the Scattering of Electromagnetic Waves from Conductors of Arbitrary Shape. II. General Case—Victorr A. Erma. 176, 1544 (1968)
ERNST, Frederick J.
Erratum: New Formulation of the Axially Symmetric Gravitational Field Problem. II—Frederick J. Ernst. [168, 1415 (1968)] 172, 1850 (1968)
ERNST, V.
Emission of Radiation from a System of Many Excited Atoms —V. Ernst and P. Stehle. 176, 1456 (1968)
ERREY, J. R.
Tunneling in Ferroelectrics—J. R. Errey. 174, 568 (1968)

ESAKI, L.
Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)

Optical and Electrical Properties and Band Structure of GeTe and SnTe—R. Tsu, W. E. Howard, and L. Esaki. 172, 779 (1968)

ESPINOSA, G. P.
Magnetic and Crystallographic Transitions in the $\alpha$-$Mn_2O_3$–$Fe_2O_3$ System—R. W. Grant, S. Geller, J. A. Cape, and G. P. Espinosa. 175, 686 (1968)

ESPOSITO, R. J.
Optical Properties of Free-Electron-Like Foils—R. J. Esposito, Philip E. Bloomfield, and L. Muldawer. 176, 886 (1968)

ESTEROWITZ, L.
Ground-State Modulation Using Optical Double Resonance in Trivalent Rare-Earth-Doped Single Crystals—L. Esterowitz and E. Chicklis. 174, 463 (1968)

ESTES, Lee E.
Quantum-Mechanical Description of Two Coupled Harmonic Oscillators—Lee E. Estes, Thomas H. Keil, and Lorenzo M. Narducci. 175, 286 (1968)

ESTLE, T. L.
Paraelectric-Resonance Spectroscopy—T. L. Estle. 176, 1056 (1968)

EVANS, J. S.
Decay of $Ho^{163}$—P. K. Hopke, J. S. Evans, and R. A. Naumann. 171, 1290 (1968)

Levels in Even-Even $Hg^{192}$, $Hg^{194}$, $Hg^{196}$, and $Hg^{198}$—R. F. Petry, R. A. Naumann, and J. S. Evans. 174, 1441 (1968)

EVERETT, Allen E.
Double Bootstrap of the $\rho$ and $f^0$—Allen E. Everett. 173, 1663 (1968)

EVERETT, Glen E.
Magnetocrystalline Anisotropy of Europium Selenide—R. F. Brown, A. W. Lawson, and Glen E. Everett. 172, 559 (1968)

EVERHART, E.
Coincidence Measurements of Krypton-Krypton Collisions—M. P. McCaughey, E. J. Knystautas, and E. Everhart. 175, 14 (1968)

EVERTS, H. U.
Electronic Spin Polarization around a Magnetic Impurity Using Perturbation Theory—H. U. Everts and B. N. Ganguly. 174, 594 (1968)

FACEY, O. E.
Color Centers in $MgF_2$—W. A. Sibley and O. E. Facey. 174, 1076 (1968)

FAGG, L. W.
Inelastic Electron Scattering from $^{24}Mg$ at 180°—L. W. Fagg, W. L. Bendel, R. A. Tobin, and H. F. Kaiser. 171, 1250 (1968)

Inelastic Electron Scattering from $^{26}Mg$ at 180°.—W. L. Bendel, L. W. Fagg, R. A. Tobin, and H. F. Kaiser. 173, 1103 (1968)

FAIMAN, David
Harmonic-Oscillator Model for Baryons—David Faiman and Archibald W. Hendry. 173, 1720 (1968)

FAIRLIE, D. B.
Chiral Symmetry from Divergence Requirements—D. B. Fairlie and K. Yoshida. 174, 1816 (1968)

FALER, K. T.
A $K^\pi = 0^+$ Band in $^{184}W$—K. T. Faler, R. R. Spencer, and R. A. Harlan. 175, 1495 (1968)

FALGE, R. L.
Ferromagnetism of $CrBe_{12}$—N. M. Wolcott and R. L. Falge, Jr. 171, 591 (1968)

FALICOV, L. M.
Symmetry of the Wave Functions in the Band Theory of Ferromagnetic Metals—L. M. Falicov and J. Ruvalds. 172, 498 (1968)

de Haas–van Alphen Effect, Exchange Splitting, Spin-Orbit Interaction, and Magnetic Breakdown in Ferromagnetic Nickel—J. Ruvalds and L. M. Falicov. 172, 508 (1968)

Fermi Surface of Cadmium: Radio-Frequency Size Effect—R. C. Jones, R. G. Goodrich, and L. M. Falicov. 174, 672 (1968)

FALLIEROS, S.
Dipole States in $Sr^{88}$—B. Goulard, T. A. Hughes, and S. Fallieros. 176, 1345 (1968)

FANELLI, Robert
Microscopic Quantum Hydrodynamics for Interacting Bose Systems—Robert Fanelli and R. E. Struzynski. 173, 248 (1968)

FANG, F. F.
Effects of a Tilted Magnetic Field on a Two-Dimensional Electron Gas—F. F. Fang and P. J. Stiles. 174, 823 (1968)

FARRELL, D. E.
Precision Measurement of Anisotropy in the Upper Critical Field of Superconducting Niobium—D. E. Farrell, B. S. Chandrasekhar, and S. Huang. 176, 562 (1968)

FARRELL, T.
Electrical Resistivity and Screening in Some Dilute Ferromagnetic Nickel Alloys—T. Farrell. 174, 564 (1968)

Hall Coefficients of Cu, Ag, and Au in the Range 4.2–300°K—J. E. A. Alderson, T. Farrell, and C. M. Hurd. 174, 729 (1968)

Anisotropic Relaxation Times and the Hall Coefficients of $\alpha$-Phase Alloys of the *IB* Metals—R. D. Barnard, J. E. A. Alderson, T. Farrell, and C. M. Hurd. 176, 761 (1968)

FASANA, A.
Erratum: Electron Longitudinal Depolarization with Great Energy Loss—L. Braicovich, B. De Michelis, and A. Fasana. [164, 1360 (1967)] 171, 1330 (1968)

Scattering of $\beta$ Radiation on a Thick Foil: Production of Transverse Polarization—L. Braicovich, B. De Michelis, and A. Fasana. 174, 460 (1968)

FASSIO-CANUTO, Laura
Quantum Theory of an Electron Gas with Anomalous Magnetic Moments in Intense Magnetic Fields—Hong-Yee Chiu, Vittorio Canuto, and Laura Fassio-Canuto. 176, 1438 (1968)

FAST, R. W.
Magnetic Flux Penetration in Type-II Superconductors. I—G. del Castillo and R. W. Fast. 175, 575 (1968)

FATE, W. A.
Low-Temperature Amplitude-Independent Longitudinal Ultrasonic Attenuation in Normal Lead—W. A. Fate. 172, 402 (1968)

Amplitude-Independent Longitudinal Ultrasonic Attenuation in Superconducting Lead—W. A. Fate, R. W. Shaw, and G. L. Salinger. 172, 413 (1968)

FAULKNER, Roger A.
Toward a Theory of Isoelectronic Impurities in Semiconductors—Roger A. Faulkner. 175, 991 (1968)

FAUST, W. L.
Dispersion in the Nonlinear Susceptibility of GaP near the Reststrahl Band—W. L. Faust, C. H. Henry, and R. H. Eick. 173, 781 (1968)

FAYYAZUDDIN
$A_1$-$\rho$-$\pi$ System and $\pi \to l\nu\gamma$ Decay—Riazuddin and Fayyazuddin. 171, 1428 (1968)

Spectral-Function Sum Rules and the Ratio $f_K/f_\pi$—Riazuddin and Fayyazuddin. 172, 1737 (1968)

FEDDERS, Peter A.
Dynamic Effects in *s-f* Antiferromagnetism—Peter A. Fedders. 172, 530 (1968)

FEDUNIAK, R. B.
Distribution of Blackbody Cavity Radiation in a Moving Frame of Reference—G. R. Henry, R. B. Feduniak, J. E. Silver, and M. A. Peterson. 176, 1451 (1968)

FEENBERG, Eugene
Variance of $H$ in the Bijl-Feynman Description of an Elementary Excitation—Tollie Davison and Eugene Feenberg. 171, 221 (1968)
Low Excited States and Statistical and Transport Properties of Liquid $He^3$—Hing-Tat Tan and E. Feenberg. 176, 370 (1968)

FEHER, Elsa
Effect of Stress on the Trigonal Splittings of $d^3$ Ions in Sapphire ($\alpha$-$Al_2O_3$)—Elsa Feher and M. D. Sturge. 172, 244 (1968)

FEIBELMAN, Peter J.
Simple Microscopic Theory of Surface Plasmons—Peter J. Feibelman. 176, 551 (1968)

FEIBUS, Howard
Electric Field Dependence of Positronium Formation in Matter—Werner Brandt and Howard Feibus. 174, 454 (1968)

FEIGELSON, R. S.
Impurity-Induced Optical Fluorescence in $MnF_2$—R. L. Greene, D. D. Sell, R. S. Feigelson, G. F. Imbusch, and H. J. Guggenheim. 171, 600 (1968)

FEINROTH, Martin
Regge Asymptotic Behavior and the Bethe-Salpeter Equation—Richard A. Brandt and Martin Feinroth. 176, 1985 (1968)

FEIT, Michael D.
Structure-Factor Approach to Migration Energy of Interstitials—Michael D. Feit and H. B. Huntington. 172, 580 (1968)

FELDMAN, D. W.
Phonon Dispersion Curves by Raman Scattering in SiC, Polytypes 3$C$, 4$H$, 6$H$, 15$R$, and 21$R$—D. W. Feldman, James H. Parker, Jr., W. J. Choyke, and Lyle Patrick. 173, 787 (1968)

FELDMANN, W. L.
Excess Currents in Superconducting Tunnel Junctions—J. M. Rowell and W. L. Feldmann. 172, 393 (1968)

FELS, Stephen Brook
Corrections to the Coleman-Glashow Sum Rule—Stephen Brook Fels. 175, 1895 (1968)

FENEUILLE, S.
Magnetic Interactions in Mixed Configurations—Lloyd Armstrong, Jr. and S. Feneuille. 173, 58 (1968)

FENTON, E. W.
Possible Cooperative Phase for Electrons in Double-Stranded DNA—E. W. Fenton. 174, 517 (1968)

FERBEL, T.
Pion Production and Elastic Scattering in Antiproton-Proton Collisions at 6.94 BeV/$c$—T. Ferbel, J. A. Johnson, H. I. Kraybill, J. Sandweiss, and H. D. Taft. 173, 1307 (1968)

FERGUSON, S. M.
Intensities and Angular Distributions of Ground-State Rotational Transitions Excited in ($\alpha$,3$n$) and ($\alpha$,4$n$) Reactions—C. F. Williamson, S. M. Ferguson, B. J. Shepherd, and I. Halpern. 174, 1544 (1968)

FERNANDEZ, J. F.
Divergences in the Space-Time Correlation Functions for the Heisenberg Magnet in One Dimension—J. F. Fernandez and H. A. Gersch. 172, 341 (1968)

FERRARI, E.
Further Comments on the Description of Three-Body Associated Production in Proton-Proton Collisions through the One-Boson-Exchange Model—E. Ferrari. 175, 2003 (1968)

FERRARO, J. R.
Pressure Dependence of Infrared Eigenfrequencies of KCl and KBr—C. Postmus, J. R. Ferraro, and S. S. Mitra. 174, 983 (1968)

FESSLER, Theodore E.
Decay of $^{136}$La and $^{134}$La—Glenn M. Julian and Theodore E. Fessler. 172, 1208 (1968)
Levels of $^{130}$Xe Populated in $\beta$ Decay of $^{130}$I and $^{130}$Cs—Theodore E. Fessler, Glenn M. Julian, and S. Jha. 174, 1472 (1968)

FICENEC, J. R.
Two-Charged-Particle Final States of $K^-p$ Interactions at 2.63 and 2.70 GeV/$c$—J. R. Ficenec, H. A. Gordon, and W. P. Trower. 175, 1725 (1968)

FICHTEL, C. E.
Cosmic-Ray Propagation—C. E. Fichtel and D. V. Reames. 175, 1564 (1968)

FIELD, Marshall B.
Erratum: Electric Properties of $n$-Type Liquid Alloys of Thallium and Tellurium—Melvin Cutler and Marshall B. Field. [169, 632 (1968)] 174, 1082 (1968)

FIELD, R. C.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

FIESCHI, R.
Positron Annihilation in Semiconductors—R. Fieschi, A. Gainotti, C. Ghezzi, and M. Manfredi. 175, 383 (1968)

FILIPPELLI, A. R.
Electron Capture into the $n$=3 States of H by Fast $H^+$ Impact on $N_2$—R. H. Hughes, B. M. Doughty, and A. R. Filippelli. 173, 172 (1968)

FILTHUTH, H.
Study of the $\Lambda$-$N$ System in Low-Energy $\Lambda$-$p$ Elastic Scattering—G. Alexander, U. Karshon, A. Shapira, G. Yekutieli, R. Engelmann, H. Filthuth, and W. Lughofer. 173, 1452 (1968)

FINK, R. W.
Gamma Rays from the Decay of $^{75}$Ge and $^{77}$Ge—Anne Ng, R. E. Wood, J. M. Palms, P. Venugopala Rao, and R. W. Fink. 176, 1329 (1968)

FINNEMORE, D. K.
Critical-Field Curves for Gapless Superconductors—W. R. Decker and D. K. Finnemore. 172, 430 (1968)
Neutron Diffraction and Susceptibility Study of Dilute La–Rare-Earth Alloys—D. K. Finnemore, L. J. Williams, F. H. Spedding, and D. C. Hopkins. 176, 712 (1968)

FIREBAUGH, M.
Strange-Particle Production in 8-BeV/$c$ Proton-Proton Interactions—M. Firebaugh, G. Ascoli, E. L. Goldwasser, R. D. Sard, and J. Wray. 172, 1354 (1968)

FISCHBACH, E.
Sum Rules for Weak $BB\pi$ Amplitudes—E. Fischbach and K. Trabert. 174, 1843 (1968)

FISCHBECK, H. J.
Intensities of Inner Beta Groups in $Ca^{47}$ and Shapes of Nonstatistical Allowed Outer Groups in $Ca^{47}$ and $P^{32}$—H. J. Fischbeck. 173, 1078 (1968)

FISCHER, Gaston
High-Frequency Surface Impedance of Dirty Type-II Superconductors in the Surface-Sheath Regime—Gaston Fischer and Kazumi Maki. 176, 581 (1968)

FISCHER, Sighart
Study of Exciton Dynamics in a Simple Liquid—Sighart Fischer and Stuart A. Rice. 176, 409 (1968)

FISHBANE, P. M.
Influence of Breakup Channels in Elastic Scattering of Composite Particles—P. M. Fishbane and J. V. Noble. 171, 1150 (1968)

FISHER, Michael E.
Renormalization of Critical Exponents by Hidden Variables—Michael E. Fisher. 176, 257 (1968)

FISHER, T. R.
Lifetimes of Levels in $A=10$ Nuclei—T. R. Fisher, S. S. Hanna, D. C. Healey, and P. Paul. 176, 1130 (1968)

FISK, H. E.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

FITZSIMMONS, W. A.
Diffusion of He($2^3S_1$) in Helium Gas; $2\,^3S_1 - 1\,^1S_0$ Interaction Potentials at Long Range—W. A. Fitzsimmons, N. F. Lane, and G. K. Walters. 174, 193 (1968)

FLEMING, D. M.
Optical-Model Analysis of Pion-Nucleus Scattering. II. Pion Form Factor—E. H. Auerbach, D. M. Fleming, and M. M. Sternheim. 171, 1781 (1968)

FLEMING, Donald G.
Observation of the Lowest $p$-Shell $T=\frac{3}{2}$ States of $^{11}$B and $^{11}$C—S. W. Cosper, Robert L. McGrath, Joseph Cerny, Creve C. Maples, George W. Goth, and Donald G. Fleming. 176, 1113 (1968)

FLEMING, Gordon N.
Timelike Reflection: the Coupling between Time Reversal and the Poincaré Group—Gordon N. Fleming. 174, 1620 (1968)

Coupling between the Poincaré Group and Space-Time or Spacelike Reflections on Hyperplanes—James T. Miller, Jr., and Gordon N. Fleming. 174, 1625 (1968)

FLETCHER, N. R.
Elastic and Inelastic Scattering of $^3$He by $^{12}$C, 12.0-18.0 MeV—H. T. Fortune, T. J. Gray, W. Trost, and N. R. Fletcher. 173, 1002 (1968)

FLEURY, P. A.
Electric-Field-Induced Raman Scattering in $SrTiO_3$ and $KTaO_3$—P. A. Fleury and J. M. Worlock. 174, 613 (1968)

FLOCKEN, John W.
Application of the Method of Lattice Statics to Interstitial Cu Atoms in Cu—John W. Flocken and John R. Hardy. 175, 919 (1968)

FLUSS, M. J.
Study of the Particles Emitted from $Br^{75}$ Compound Nuclei Formed in Two Ways: $C^{12} + Cu^{63}$ and $O^{16} + Co^{59}$—J. M. D'Auria, M. J. Fluss, G. Herzog, L. Kowalski, J. M. Miller, and R. C. Reedy. 174, 1409 (1968)

FLYNN, C. P.
Atomic Migration in Monatomic Crystals—C. P. Flynn. 171, 682 (1968)

FOLDY, L. L.
Statistical Model for High-Energy Reactions—L. L. Foldy, H. Kottler, D. R. Speiser, and J. Weyers. 173, 1517 (1968)

FOLTZ, N. D.
Stimulated Thermal Rayleigh Scattering in Liquids—C. W. Cho, N. D. Foltz, D. H. Rank, and T. A. Wiggins. 175, 271 (1968)

FONDA, L.
Transformation Properties and Relativistic Equations for Spin-One Elementary Systems—L. Fonda and G. C. Ghirardi. 175, 2082 (1968)

FOO, E-Ni
Fermi-Liquid Effects on High-Frequency Wave Propagation in Simple Metals—P. M. Platzman, W. M. Walsh, Jr., and E-Ni Foo. 172, 689 (1968)

Optical Absorption and Energy Loss in Sodium in the Hartree Approximation—E-Ni Foo and J. J. Hopfield. 173, 635 (1968)

FORBRICH, Carl A., Jr.
Measurement of the Sodium $D$-Line Absolute Oscillator Strengths by the Roschdestvenskii Hook Method—Carl A. Forbrich, Jr., Wayland C. Marlow, and Daniel Bershader. 173, 150 (1968)

FORD, J. L. C., Jr.
Coulomb-Recoil-Implantation Mössbauer Experiments with $^{73}$Ge—Gordon Czjzek, J. L. C. Ford, Jr., John C. Love, Felix E. Obenshain, and Horst H. F. Wegener. 174, 331 (1968)

FORD, Joseph
Lattice Thermal Conductivity for a One-Dimensional, Harmonic, Isotopically Disordered Crystal—Kenneth R. Allen and Joseph Ford. 176, 1046 (1968)

FORD, Kenneth W.
Electrodynamics with a Quantum of Length—Kenneth W. Ford. 175, 2048 (1968)

FORMAN, F.
1-BeV Electron Compton Scattering near 180°—B. Gittelman, W. C. Barber, W. Selove, D. Tompkins, and F. Forman. 171, 1388 (1968)

FORMAN, Richard A.
Electroreflectance Measurements on $Mg_2Si$, $Mg_2Ge$, and $Mg_2Sn$—F. Vazquez, Richard A. Forman, and Manuel Cardona. 176, 905 (1968)

FORTUNE, H. T.
Elastic and Inelastic Scattering of $^3$He by $^{12}$C, 12.0-18.0 MeV—H. T. Fortune, T. J. Gray, W. Trost, and N. R. Fletcher. 173, 1002 (1968)

FOSDICK, Lloyd D.
Three-Particle Effects in the Pair Distribution Function for $He^4$ Gas—Harry F. Jordan and Lloyd D. Fosdick. 171, 128 (1968)

FOSSHEIM, K.
Nonlinear Effect in the Shear-Wave Attenuation near $T_c$ in Superconductors—K. Fossheim. 173, 526 (1968)

FOSTER, J. L., Jr.
Isobaric Analog Resonances in Proton Scattering from $^{124}$Te, $^{126}$Te, $^{128}$Te, and $^{130}$Te—J. L. Foster, Jr., P. J. Riley, and C. Fred Moore. 175, 1498 (1968)

$^{136}$Xe($d,p$) and $^{136}$Xe($d,t$) Reactions—P. A. Moore, P. J. Riley, C. M. Jones, M. D. Mancusi, and J. L. Foster, Jr. 175, 1516 (1968)

FOU, C. M.
($^3$He,$\alpha$) Reaction on $^{89}$Y and $^{86}$Kr at 18 MeV—C. M. Fou and R. W. Zurmühle. 176, 1339 (1968)

FOWLER, H. A.
Reflectance and $1/\epsilon$ Resonance of Beryllium in the Far Ultraviolet—J. Toots, H. A. Fowler, and L. Marton. 172, 670 (1968)

FOWLER, W. Beall
Electronic States of the $F$ Center in Alkali Halide Crystals—W. Beall Fowler. 174, 988 (1968)

Electronic Bubble States in Liquid Helium—W. Beall Fowler and D. L. Dexter. 176, 337 (1968)

FOX, G. C.
Regge Secondary Trajectories—G. C. Fox and L. Sertorio. 176, 1739 (1968)

FOX, Kenneth
Ground-State Energy Eigenvalues and Eigenfunctions for an Electron in an Electric-Dipole Field—J. E. Turner, V. E. Anderson, and Kenneth Fox. 174, 81 (1968)

FOX, R. L.
Erratum: Calculation of Low-Energy Electron-Atom Transport Cross Sections from Total Cross-Section Measurements—R. L. Fox. [168, 1 (1968)] 173, 325 (1968)

FRAIME, C. R.
Ultraviolet Reflectivity Spectra of $CdS_{1-x}Se_x$ Single Crystals—R. L. Hengehold and C. R. Fraime. 174, 808 (1968)

FRANCIS, N. C.
Coupled-Channel Calculation of $C^{12}$-Neutron Scattering—J. T. Reynolds, C. J. Slavik, C. R. Lubitz, and N. C. Francis. 176, 1213 (1968)

FRANCIS, Samuel H.
Wave Coupling Across a Shock Wave in a Fully Ionized Gas—Samuel H. Francis and David Kahn. 172, 181 (1968)

FRANCO, Victor
High-Energy Nucleus-Nucleus Collisions. I. General Theory and Applications to Deuteron-Deuteron Scattering—Victor Franco. 175, 1376 (1968)

FRANKEL, R. B.
Three-Quasiparticle Intruder State in $Te^{125}$ and the Magnetic Moment of $Sb^{125}$—N. J. Stone, R. B. Frankel, and D. A. Shirley. 172, 1243 (1968)

FRANKLIN, Jerrold
A Model of Baryons Made of Quarks with Hidden Spin—Jerrold Franklin. 172, 1807 (1968)
Electromagnetic Properties of Baryons in a Quark-Diquark Model with Broken $SU(6)$—James Carroll, D. B. Lichtenberg, and J. Franklin. 174, 1681 (1968)

FRANZ, E. M.
Alpha Branching Ratio in the Decay of $^{149}Tb$—Y. Y. Chu, E. M. Franz, and G. Friedlander. 175, 1523 (1968)

FRASER, J. C.
Superfluid Fraction of Liquid Helium Contained in Porous Vycor Glass—J. C. Fraser and I. Rudnick. 176, 421 (1968)

FRAUTSCHI, S.
Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: General Features—P. Babu, S. Frautschi, and N. S. Thornber. 172, 1389 (1968)

FRAZER, W. R.
$O(4)$ Symmetry and the Regge Trajectory of the Pion—W. R. Frazer, H. M. Lipinski, and D. R. Snider. 174, 1932 (1968)
$O(4)$ Expansion of Off-Shell Scattering Amplitudes—W. R. Frazer, F. R. Halpern, H. M. Lipinski, and D. R. Snider. 176, 2047 (1968)

FREDERICK, David E.
$C^{12}(p,p)B^{11}$ Angular Distributions In and Just Above the Giant Resonance—David E. Frederick and A. Daniel Sherick. 176, 1177 (1968)

FREDKIN, Donald R.
Spin Waves in $He^3$ in the Paramagnon Model—Shang-keng Ma, M. T. Béal-Monod, and Donald R. Fredkin. 174, 227 (1968)

FREED, Karl F.
Many-Body Approach to Electron Correlation in Atoms and Molecules—Karl F. Freed. 173, 1 (1968)
Generalized Perturbation Theory and its Application to the Problem of the Description of Electron Correlation in Atoms and Molecules—Karl F. Freed. 173, 24 (1968)

FREEMAN, A. J.
Theory of Transition-Metal Complexes: Unrestricted Hartree-Fock Molecular-Orbital Method and Its Application to $KNiF_3$—D. E. Ellis, A. J. Freeman, and P. Ros. 176, 688 (1968)

FREIER, P. S.
Very Heavy Nuclei in the Primary Cosmic Radiation. I. Observations on the Energy Spectrum—P. S. Freier and C. J. Waddington. 175, 1641 (1968)
Very Heavy Nuclei in the Primary Cosmic Radiation. II. Interpretation of the Energy Spectra—C. J. Waddington and P. S. Freier. 175, 1649 (1968)

FRENCH, B. T.
Effect of a Uniform Electric Field upon the Optical Absorption of Semi-Insulating Gallium Arsenide—B. T. French. 174, 991 (1968)

FRENCH, R. A.
Effect of Temperature and of Substitutional Mo on the Magnetic Behavior of Superconducting Nb—R. A. French and J. Lowell. 173, 504 (1968)

FRESCO, J. M.
Identification of 5.3-sec $^{118}Ag$ as a Product of $^{238}U$ Fission—H. V. Weiss, J. M. Fresco, and W. L. Reichert. 172, 1266 (1968)
Identification and Yield of 5.0-sec $^{117}Pd$ in the Thermal-Neutron Fission of $^{235}U$—H. V. Weiss, J. L. Elzie, and J. M. Fresco. 172, 1269 (1968)

FREUND, Peter G. O.
Scalar Fields Coupled to the Trace of the Energy-Momentum Tensor—Peter G. O. Freund and Yoichiro Nambu. 174, 1741 (1968)

FRIDMAN, A.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)
Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/$c$—A. Fridman, G. Maurer, A. Michalon, J. Oudet, R. Straub, C. Voltolini, and P. Cüer. 176, 1595 (1968)

FRIED, H. M.
Correlation between Transcendental and Polynomial Lagrangians—H. M. Fried. 174, 1725 (1968)

FRIEDBERG, S. A.
Linear Chain Antiferromagnetism in $CsMnCl_3 \cdot 2H_2O$—T. Smith and S. A. Friedberg. 176, 660 (1968)
Heat Capacity of $Mn(CH_3COO)_2 \cdot 4H_2O$ between 0.4 and 20°K—J. H. Schelleng, C. A. Raquet, and S. A. Friedberg. 176, 708 (1968)

FRIEDLANDER, G.
Alpha Branching Ratio in the Decay of $^{149}Tb$—Y. Y. Chu, E. M. Franz, and G. Friedlander. 175, 1523 (1968)
Effects of Using a Velocity-Dependent Potential in a Monte Carlo Simulation of Intranuclear Cascades—K. Chen, G. Friedlander, and J. M. Miller. 176, 1208 (1968)

FRIEDMAN, F.
Magnetic Properties of Uranium Compounds with Elements of the VA and VIA Groups. I. Compounds of UX Type—J. Grunzweig-Genossar, M. Kuznietz, and F. Friedman. 173, 562 (1968)

FRIEDMAN, Lionel
Current Fluctuations in the Acoustoelectric Steady State—Lionel Friedman. 174, 737 (1968)

FRIEDMAN, M. H.
Hard-Pion Current-Algebra Calculation of Meson Processes—Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 1999 (1968)

Application of Hard-Pion Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 2008 (1968)
Hard-Pion Current-Algebra Calculation of Meson Processes—$N$-Point Functions—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1802 (1968)
Application of Hard-Pion Four-Point Functions to Pion-Pion Scattering—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1820 (1968)

FRISCH, D. H.
Charge-Exchange $K^- + p \to \bar{K}^0 + n$ at 7.7 GeV/$c$—A. Buffington, D. H. Frisch, and C. E. W. Ward. 176, 1628 (1968)

FRISHMAN, Y.
Construction of Local Quantum Fields Describing Many Masses and Spins—Henry D. I. Abarbanel and Y. Frishman. 171, 1442 (1968)

FRITZ, I. J.
Electron Spin Resonance of $Zn(ClO_4)_2 \cdot 6H_2O{:}Mn^{2+}$ in a Parallel and Perpendicular Configuration—I. J. Fritz and Leonard Yarmus. 173, 445 (1968)

FROMHOLD, A. T., Jr.
Kinetics of Oxide Film Growth on Metal Crystals: Electronic and Ionic Diffusion in Large Surface-Charge and Space-Charge Fields—A. T. Fromhold, Jr., and Earl L. Cook. 175, 877 (1968)

FROMMHOLD, Lothar
Resonance Scattering and the Drift Motion of Electrons Through Gases—Lothar Frommhold. 172, 118 (1968)

FRONSDAL, Christian
Relativistic Lagrangian Field Theory for Composite Systems—Christian Fronsdal. 171, 1811 (1968)
Model for Leptonic Interactions. II. Is the Pion the Intermediate Boson?—Christian Fronsdal. 176, 1846 (1968)

FROSCH, R. F.
Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)

FUCHS, Norman H.
$K_{l3}$-Decay Form Factors, Current Algebra, and Subtracted Dispersion Relations. II—Norman H. Fuchs. 172, 1532 (1968)

FUCHS, Ronald
Anomalous Skin Effect for Specular Electron Scattering and Optical Experiments at Non-Normal Angles of Incidence—K. L. Kliewer and Ronald Fuchs. 172, 607 (1968)

FUDA, Michael G.
Separable $t$ Matrices and Hard-Core Potentials—Michael G. Fuda. 174, 1134 (1968)

FUJITA, Jun-Ichi
Practical Method for the Treatment of Nuclear Collective Motions—Jun-Ichi Fujita. 172, 1047 (1968)
Hindrance Factors for Beta Decays of Heavy Nuclei—Hiroyasu Ejiri, Kiyomi Ikeda, and Jun-Ichi Fujita. 176, 1277 (1968)

FUJIWARA, I.
Angular-Distribution Study of the $Cu^{63}(He^3,xn)$ Reaction Products—I. Fujiwara and N. T. Porile. 173, 1055 (1968)
Differential Range Study of $(\alpha,xn)$ Reactions of Copper—N. T. Porile and I. Fujiwara. 176, 1166 (1968)

FUKUSHIMA, Eiichi
Nuclear-Spin-Diffusion Relaxation to a Finite Density of Paramagnetic Impurity Ions—Eiichi Fukushima and Edwin A. Uehling. 173, 366 (1968)

FULCO, J. R.
Ground State of Three Alpha Particles—J. R. Fulco and D. Y. Wong. 172, 1062 (1968)

FULDE, Peter
Spin Relaxation and Transport in Magnetic Alloys—Peter Fulde and Alan Luther. 175, 337 (1968)

FULKERSON, W.
Specific Heat of Uranium Mononitride from 1.3 to 4.6°K—J. O. Scarbrough, H. L. Davis, W. Fulkerson, and J. O. Betterton, Jr. 176, 666 (1968)

FULLER, Robert G.
Ionic Transport in Potassium Chloride—Robert G. Fuller, Charles L. Marquardt, Michael H. Reilly, and John C. Wells, Jr. 176, 1036 (1968)

FULMER, C. B.
Excitation Functions for Radioactive Isotopes Produced by Proton-Induced Reactions in Silicon—D. W. Sheffey, I. R. Williams, and C. B. Fulmer. 172, 1094 (1968)
Neutron Hole States in $Z = 40$ Nuclei Studied with the $(p,d)$ Reaction on $^{90}Zr$, $^{91}Zr$, and $^{92}Zr$—J. B. Ball and C. B. Fulmer. 172, 1199 (1968)

FULTON, T. A.
dc Josephson Effect for Strong-Coupling Superconductors—T. A. Fulton and D. E. McCumber. 175, 585 (1968)

GABBARD, F.
$^{40}Ar(p,n)^{40}K$ Reaction from Threshold to 5.0 MeV—T. M. Young, J. D. Brandenberger, and F. Gabbard. 172, 1148 (1968)
$2^-$ Isobaric Analog Resonance in the $^{89}Y(p,n_2)^{89}Zr$ Reaction and the Excited States of $^{89}Zr$—G. C. Dutt, F. Gabbard, J. J. Egan, and J. E. Wiest. 176, 1289 (1968)

GADIOLI, E.
Theoretical Calculations of Statistical Heavy-Ion Reactions—E. Gadioli, I. Iori, and L. Zetta. 174, 1140 (1968)

GAINOTTI, A.
Positron Annihilation in Semiconductors—R. Fieschi, A. Gainotti, C. Ghezzi, and M. Manfredi. 175, 383 (1968)

GALATI, W.
Proton-Induced Reactions on $^{40}Ar$ and Analogs of $^{41}Ar$ Levels—H. L. Scott, W. Galati, J. L. Weil, and M. T. McEllistrem. 172, 1139 (1968)

GALBRAITH, Lee K.
Optical Third-Harmonic Generation in Dye Solutions—R. K. Chang and Lee K. Galbraith. 171, 993 (1968)

GALLAGHER, Alan
Rubidium and Cesium Excitation Transfer in Nearly Adiabatic Collisions with Inert Gases—Alan Gallagher. 172, 88 (1968)

GALLAGHER, J. J.
Hyperfine Structure in the Millimeter Spectrum of Hydrogen Sulfide: Electric Resonance Spectroscopy on Asymmetric-Top Molecules—R. E. Cupp, R. A. Kempf, and J. J. Gallagher. 171, 60 (1968)

GALLAGHER, Jean W.
Transverse Magnetoresistance and Hall Effect in $p$-Type Germanium—Jean W. Gallagher. 171, 987 (1968)

GALLAHER, D. F.
Erratum: Coupled-State Calculations of Proton-Hydrogen Scattering in the Sturmian Representation—D. F. Gallaher and L. Wilets. [169, 139 (1968)] 176, 423 (1968)

GALLMANN, A.
Positron Decays of $^{38}Ca$ and $^{38}K$—R. W. Kavanagh, A. Gallmann, E. Aslanides, F. Jundt, and E. Jacobs. 175, 1426 (1968)

GAMMEL, John L.
Reaction Amplitudes for Pseudoscalar Mesons on Spin-$\frac{1}{2}$ Fermions in Fourth-Order Perturbation Theory—Joseph J. Kubis and John L. Gammel. 172, 1664 (1968)

GANAS, P. S.
Green's Velocity-Dependent Potential in the Shell Model of $Po^{210}$, $Pb^{210}$, and $Bi^{210}$—P. S. Ganas and Bruce H. J. McKellar. 175, 1409 (1968)

GANGULY, B. N.
Electronic Spin Polarization around a Magnetic Impurity Using Perturbation Theory—H. U. Everts and B. N. Ganguly. 174, 594 (1968)

GANIEL, U.
Erratum: Theory of Magnetically Induced Electric Field Gradients in Cubic $Fe^{2+}$—U. Ganiel and S. Shtrikman. [167, 258 (1968)] 173, 630 (1968)

GARDNER, W. E.
Superconductivity of α-Phase U-Mo Alloys at Zero and High Pressures—J. E. Gordon, W. E. Gardner, T. F. Smith, C. W. Chu, and M. B. Maple. 176, 556 (1968)

GARFUNKEL, M. P.
Surface Impedance of Type-I Superconductors: Calculation of the Effect of a Static Magnetic Field—M. P. Garfunkel. 173, 516 (1968)

GARRETT, C. G. B
Theory of Parametric Gain near a Lattice Resonance—C. H. Henry and C. G. B. Garrett. 171, 1058 (1968)

GARRETT, G. J.
Spins and Nuclear Moments of $Sb^{115}$, $Sb^{117}$, $Sb^{118}$, $Sb^{119}$, and $Sb^{120}$—A. D. Jackson, Jr., E. H. Rogers, Jr., and G. J. Garrett. 175, 65 (1968)

GARROD, Claude
Angular Symmetry of the 2-Matrix—Claude Garrod. 172, 173 (1968)

GARSIDE, L.
Extended *R*-Matrix Theory of Nuclear Reactions—L. Garside and W. Tobocman. 173, 1047 (1968)

GARTENHAUS, S.
Critical-Point Behavior of a Model Describing a System of Interacting Fermions—S. Gartenhaus and G. Stranahan. 173, 260 (1968)

GARVEY, J.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)

Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

GARY, G. A.
Analytic Continuation of an Amplitude—W. J. Abbe and G. A. Gary. 174, 2015 (1968)

GASH, Philip
Ion-Size Effects in Color Centers—R. H. Bartram, A. M. Stoneham, and Philip Gash. 176, 1014 (1968)

GAVENDA, J. D.
Magnetic Field Dependence of the Velocity of Sound in Ultrapure Cd and Cu—B. G. W. Yee and J. D. Gavenda. 175, 805 (1968)

GAY, J. G.
Mechanism for the Photoreflectance Effect—J. G. Gay and L. T. Klauder, Jr. 172, 811 (1968)

GAZZINELLI, Ramayana
Electron-Nuclear Double Resonance of the Self-Trapped Hole in LiF—Ramayana Gazzinelli and Robert Lee Mieher. 175, 395 (1968)

GEHLOT, G. L.
Exact Internal Solutions for Dense Massive Stars—M. C. Durgapal and G. L. Gehlot. 172, 1308 (1968)

GEISSLER, Klaus H.
Classical and Anomalous Diffusion of an Afterglow Plasma—Klaus H. Geissler. 171, 179 (1968)

GELINAS, R. J.
Time-Dependent Behavior of a Class of Nonequilibrium Radiating Systems—R. J. Gelinas. 175, 300 (1968)

GELLER, S.
Magnetic and Crystallographic Transitions in the α-$Mn_2O_3$–$Fe_2O_3$ System—R. W. Grant, S. Geller, J. A. Cape, and G. P. Espinosa. 175, 686 (1968)

GELLETLY, W.
$Ba^{137}(n,\gamma)$ Reaction and Level Structure of $Ba^{138}$—M. A. J. Mariscotti, W. Gelletly, J. A. Moragues, and W. R. Kane. 174, 1485 (1968)

GELL-MANN, Murray
Behavior of Current Divergences under $SU_3 \times SU_3$—Murray Gell-Mann, R. J. Oakes, and B. Renner. 175, 2195 (1968)

GEMMELL, D. S.
Effects Seen in the Passage of Positively Charged Ions through Single Crystals—R. E. Holland and D. S. Gemmell. 173, 344 (1968)

GENTNER, R. F.
Calculation of the $^1S$ State of the Beryllium Atom in Hylleraas Coordinates—R. F. Gentner and E. A. Burke. 176, 63 (1968)

GEORGE, David J.
Modified Dispersion Relations and ππ Scattering—David J. George, Barbara Hale, and Arnold Tubis. 172, 1740 (1968)

Application of Modified Dispersion Relations to the Forward *KN* Crossing-Even Scattering Amplitude—David J. George and Arnold Tubis. 174, 1871 (1968)

Regge Parameters in Crossing-Even *KN* Scattering—David J. George and Arnold Tubis. 174, 1875 (1968)

GERHARDT, Ulrich
Effect of Uniaxial and Hydrostatic Strain on the Optical Constants and the Electronic Structure of Copper—Ulrich Gerhardt. 172, 651 (1968)

GERLACH, Ulrich H.
Equation of State at Supranuclear Densities and the Existence of a Third Family of Superdense Stars—Ulrich H. Gerlach. 172, 1325 (1968)

GERSCH, H. A.
Divergences in the Space-Time Correlation Functions for the Heisenberg Magnet in One Dimension—J. F. Fernandez and H. A. Gersch. 172, 341 (1968)

GERSTEIN, Ira S.
Structure of Three-Point Functions from $SU(3) \otimes SU(3)$ Algebra—Ira S. Gerstein, Howard J. Schnitzer, and Steven Weinberg. 175, 1873 (1968)

Chiral $SU(3) \otimes SU(3)$ Three-Point Function: Single-Particle Approximation—Ira S. Gerstein and Howard J. Schnitzer. 175, 1876 (1968)

GERSTEN, Alexander
Low-Energy Properties of Realistic *N-N* One-Boson-Exchange Potentials—Alexander Gersten and A. E. S. Green. 176, 1199 (1968)

GERTLER, F. H.
Adiabatic Approximation and Necessary Conditions for the Existence of Bound States—F. H. Gertler, H. B. Snodgrass, and Larry Spruch. 172, 110 (1968)

GEZELTER, J.
Charge-Exchange Scattering of $K^+$ Mesons from Beryllium at 0.97 BeV/c—J. Gezelter, G. L. Salmon, F. V. Murphy, G. K. O'Neill, and R. Grismore. 173, 1315 (1968)

GHEZZI, C.
Positron Annihilation in Semiconductors—R. Fieschi, A. Gainotti, C. Ghezzi, and M. Manfredi. 175, 383 (1968)

GHIORSO, Albert
Analysis of Excitation Functions in Cm(C,xn)No Reactions—Torbjorn Sikkeland, Albert Ghiorso, and Matti J. Nurmia. 172, 1232 (1968)
GHIRARDI, G. C.
Transformation Properties and Relativistic Equations for Spin-One Elementary Systems—L. Fonda and G. C. Ghirardi. 175, 2082 (1968)
GIALLORENZI, T. G.
Erratum: Quantum Theory of Spontaneous Parametric Scattering of Intense Light—T. G. Giallorenzi and C. L. Tang. [166, 225 (1968)] 171, 610 (1968)
GIBBERD, R. W.
Combinatorial Approach to the Ferroelectric Problem—R. W. Gibberd. 171, 563 (1968)
GIBBONS, James F.
Periodic Dependence of the Electronic Stopping Cross Section for Energetic Heavy Ions in Solids—Ahmed H. Elhoshy and James F. Gibbons. 173, 454 (1968)
GIBSON, E. F.
Lifetimes, Energies, and Branching Ratios of $^{28}$Si Excited States—E. F. Gibson, K. Battleson, and D. K. McDaniels. 172, 1004 (1968)
GILAT, G.
Accurate Numerical Method for Calculating Frequency Distribution Functions in Solids. III. Extension to Tetragonal Crystals—Z. Kam and G. Gilat. 175, 1156 (1968)
GILLEO, M. A.
Free-Carrier and Exciton Recombination Radiation in GaAs—M. A. Gilleo, P. T. Bailey, and D. E. Hill. 174, 898 (1968)
GILLESPIE, John R.
Second Born Corrections to Wide-Angle High-Energy Electron Pair Production and Bremsstrahlung—Stanley J. Brodsky and John R. Gillespie. 173, 1011 (1968)
GILLIS, N. S.
Erratum: Towards a Quantum Many-Body Theory of Lattice Dynamics. II. Collective Fluctuation Approximation—N. S. Gillis and N. R. Werthamer. [167, 607 (1968)] 173, 918 (1968)
Calculation of the Self-Consistent Phonon Spectrum of hcp $He^4$—N. S. Gillis, T. R. Koehler, and N. R. Werthamer. 175, 1110 (1968)
GILMAN, Frederick J.
$K_2^0+p \to K_1^0+p$ and the Regge Trajectory of the $\omega$ Meson—Frederick J. Gilman. 171, 1453 (1968)
GINDLER, J. E.
Neutron Resonances of $Th^{230}$—R. E. Coté, H. Diamond, J. E. Gindler, and Hla Shwe. 176, 1421 (1968)
GINSBERG, D. M.
Experimental Test of the Theory of the Proximity Effect in Superconductors—A. E. Jacobs and D. M. Ginsberg. 175, 569 (1968)
GINSBERG, Edward S.
Radiative Corrections to $K_{e3}^0$ Decays and the $\Delta I=\frac{1}{2}$ Rule—Edward S. Ginsberg. 171, 1675 (1968)
Erratum: Radiative Corrections to $K_{e3}^0$ Decays and the $\Delta I=\frac{1}{2}$ Rule—Edward S. Ginsberg. [171, 1675 (1968)] 174, 2169 (1968)
GIOVANNINI, A.
Elastic Unitarity and Phase Equality of Scattering Amplitudes—A. Giovannini, E. Predazzi, and F. Selleri. 173, 1660 (1968)
GITTELMAN, B.
1-BeV Electron Compton Scattering near 180°—B. Gittelman, W. C. Barber, W. Selove, D. Tompkins, and F. Forman. 171, 1388 (1968)
Determination of the Isotensor Electromagnetic Current from Pion Photoproduction—B. Gittelman and W. Schmidt. 175, 1998 (1968)
GITTLEMAN, J. I.
Microwave Properties of Granular Superconductors—Roger W. Cohen and J. I. Gittleman. 176, 500 (1968)
GLADSTONE, G.
Ground State of the Magnetic Impurity Problem; Nuclear-Magnetic-Resonance Studies of Dilute Copper Alloys—A. J. Heeger, L. B. Welsh, M. A. Jensen, and G. Gladstone. 172, 302 (1968)
GLASS, A. M.
Dielectric, Thermal, and Pyroelectric Properties of Ferroelectric $LiTaO_3$—A. M. Glass. 172, 564 (1968)
GLASS, Leon
Unified Approximation for the Velocity Autocorrelation Function and the Structure Function of a Simple Liquid—Leon Glass and Stuart A. Rice. 176, 239 (1968)
GLASS, Solomon
Quantum Theory of the Smith-Purcell Experiment—Solomon J. Glass and H. Mendlowitz. 174, 57 (1968)
GLASSER, M. L.
Erratum: Effective Magnetic Field in Metals—J. I. Kaplan and M. L. Glasser. [170, 649 (1968)] 173, 918 (1968)
Magnetic Field Dependence of the Ruderman-Kittel-Kasuya-Yosida Exchange Interaction—M. L. Glasser. 174, 424 (1968)
Comments and Addenda: Influence of Band Structure on the Nonlocal Conductivity of Metals and the Anomalous Skin Effect—M. L. Glasser. 176, 1110 (1968)
GLASSER, R. G.
Final States with Two or More Strange Particles from 4.25-BeV/$c$ $K^-p$ Interactions—G. S. Abrams, R. G. Glasser, B. Kehoe, B. Sechi-Zorn, and G. Wolsky. 175, 1697 (1968)
GLASSGOLD, A. E.
Angular Distribution of the Outgoing Electrons in Electronic Ionization—A. E. Glassgold and G. Ialongo. 175, 151 (1968)
GLAZE, James A.
Faraday Rotation of the CaO $F$ Band and 3557 Å Zero-Phonon Peak—James C. Kemp, William M. Ziniker, James A. Glaze, and Jack C. Cheng. 171, 1024 (1968)
GLEESON, A. M.
Threshold Electropion Production from Current Algebra and Partially Conserved Axial-Vector Current—A. M. Gleeson, M. G. Gundzik, and Jacob G. Kuriyan. 173, 1708 (1968)
GLIMM, I. James
A $\lambda\varphi^4$ Quantum Field Theory Without Cutoffs. I. James Glimm and Arthur Jaffe. 176, 1945 (1968)
GLUCK, P.
Density Matrices in the Many-Body Problem—P. Gluck. 176, 1534 (1968)
GLYDE, H. R.
Self-Diffusion in Solid Argon—E. H. C. Parker, H. R. Glyde, and B. L. Smith. 176, 1107 (1968)
GMITRO, M.
Success and Limitations of Two- and Four-Quasiparticle Tamm-Dancoff Theories of Vibrational States: Applications to Even Tin Isotopes with a Realistic Nucleon-Nucleon Potential—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 173, 964 (1968)
Microscopic Theory of Effective Operators for Electromagnetic Interactions in Nuclei—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 175, 1243 (1968)
GOBLE, Robert L.
Soft Photons and the Classical Limit—Lowell S. Brown and Robert L. Goble. 173, 1505 (1968)

GODDARD, William A., III
Concerning the Stability of the Negative Ions $H^-$ and $Li^-$—William A. Goddard. III. 172, 7 (1968)
Erratum: A New Type of Wave Function for Li, $Be^+$, and $B^{++}$—William A. Goddard, III. [169, 120 (1968)] 173, 325 (1968)
New Foundation for the Use of Pseudopotentials in Metals—William A. Goddard, III. 174, 659 (1968)
Magnetic Hyperfine Structure and Core Polarization in the Excited States of Lithium—William A. Goddard, III. 176, 106 (1968)
GOITEIN, M.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)
GOLD, Albert
Polarization Dependence of Two-Photon Absorption in Solids—Todd R. Bader and Albert Gold. 171, 997 (1968)
GOLD, Raymond
Spontaneous-Fission Decay Constant of $^{238}U$—J. H. Roberts, Raymond Gold, and Roland J. Armani. 174, 1482 (1968)
GOLDBERG, Hyman
Backward ($\theta=180°$) $\pi N$ Dispersion Relations: Applications to the Interference Model, $P$ and $P'$ Trajectories, and to the Mechanical Form Factors of the Nucleon—Hyman Goldberg. 171, 1485 (1968)
Dynamics at High Spin of the $\rho$-$A_2$ Trajectory—Hyman Goldberg. 174, 1913 (1968)
GOLDBERG, Lawrence S.
Optical and Electron-Spin-Resonance Studies of the $ICl^-$ $V_K$ Center in KCl:I—Lawrence S. Goldberg and Marvin L. Meistrich. 172, 877 (1968)
GOLDBERGER, M. L.
Photon Scattering from Bound Atomic Systems at Very High Energy—M. L. Goldberger and F. E. Low. 176, 1778 (1968)
GOLDHABER, Alfred S.
High-Energy Hadron-Nucleus Collisions. I. Protons—Alfred S. Goldhaber and Charles J. Joachain. 171, 1566 (1968)
GOLDMAN, L. H.
$g_{7/2}$-$h_{11/2}$ Anomaly in Stripping Studies near $A=110$—B. L. Cohen, R. A. Moyer, J. B. Moorhead, L. H. Goldman, and R. C. Diehl. 176, 1401 (1968)
GOLDMAN, Victor V.
Debye-Waller Factors in Rare-Gas Solids—Victor V. Goldman. 174, 1041 (1968)
GOLDSTEIN, Louis
Theory of Magnetized Solid Helium Three—Louis Goldstein. 171, 194 (1968)
Crystalline Transformation of Helium Three—Louis Goldstein. 176, 311 (1968)
GOLDWASSER, E. L.
Strange-Particle Production in 8-BeV/$c$ Proton-Proton Interactions—M. Firebaugh, G. Ascoli, E. L. Goldwasser, R. D. Sard, and J. Wray. 172, 1354 (1968)
Reactions $K^-p \to \Sigma^\pm \pi^\mp$ at 4.07 and 5.47 GeV/$c$—J. S. Loos, U. E. Kruse, and E. L. Goldwasser. 173, 1330 (1968)
GOLIN, Stuart.
Band Model for Bismuth-Antimony Alloys—Stuart Golin. 176, 830 (1968)
GOLOWICH, E.
$SU(3)$-Symmetry Breaking in a Bethe-Salpeter Bootstrap Model—E. Golowich. 172, 1834 (1968)
GONSER, U.
Mössbauer Faraday Effect—R. M. Housley and U. Gonser. 171, 480 (1968)
GONTIER, Y.
Multiphoton Ionization of Atomic Hydrogen in the Ground State—Y. Gontier and M. Trahin. 172, 83 (1968)
GOOD, R. H.
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)
GOODENOUGH, John B.
Spin-Orbit-Coupling Effects in Transition-Metal Compounds—John B. Goodenough. 171, 466 (1968)
GOODMAN, Bernard
Displacement Correlations and Frequency Spectra for Mass-Disordered Lattices. II—Paul L. Leath and Bernard Goodman. 175, 963 (1968)
GOODMAN, John M.
Helicon Waves, Surface-Mode Loss, and the Accurate Determination of the Hall Coefficients of Aluminum, Indium, Sodium, and Potassium—John M. Goodman. 171, 641 (1968)
GOODMAN, L. S.
Magnetic Hyperfine Interaction Constants and Electronic $g$ Factors for Eight Atomic States of $Rh^{103}$—Y. W. Chan, W. J. Childs, and L. S. Goodman. 173, 107 (1968)
GOODRICH, R. G.
Fermi Surface of Cadmium: Radio-Frequency Size Effect—R. C. Jones, R. G. Goodrich, and L. M. Falicov. 174, 672 (1968)
GOODSTEIN, D. L.
Ion Mobility Discontinuities in Superfluid Helium: A Test of the Huang-Olinto Theory—D. L. Goodstein, U. Buontempo, and M. Cerdonio. 171, 181 (1968)
GORDON, H. A.
Two-Charged-Particle Final States of $K^-p$ Interactions at 2.63 and 2.70 GeV/$c$—J. R. Ficenec, H. A. Gordon, and W. P. Trower. 175, 1725 (1968)
GORDON, J. E.
Superconductivity of $\alpha$-Phase U-Mo Alloys at Zero and High Pressures—J. E. Gordon, W. E. Gardner, T. F. Smith, C. W. Chu, and M. B. Maple. 176, 556 (1968)
GORDON, J. P.
Donor-Acceptor Pair Recombination Involving the First Excited State of a Donor in GaAs—Jagdeep Shah, R. C. C. Leite, and J. P. Gordon. 176, 938 (1968)
GORDY, Walter
Electron Spin Resonance of Free Radicals Formed from Group-IV and Group-V Hydrides in Inert Matrices at Low Temperature—George S. Jackel and Walter Gordy. 176, 443 (1968)
Matrix Perturbations of the ESR of Trapped H, N, P, and As Atoms at 4.2°K—George S. Jackel, William H. Nelson, and Walter Gordy. 176, 453 (1968)
GOSWAMI, A. K.
Pressure and Temperature Dependence of the Dielectric Properties of the Perovskite Barium Titanate—A. K. Goswami and L. E. Cross. 171, 549 (1968)
GOTH, George W.
Observation of the Lowest $p$-Shell $T=\frac{3}{2}$ States of $^{11}B$ and $^{11}C$—S. W. Cosper, Robert L. McGrath, Joseph Cerny, Creve C. Maples, George W. Goth, and Donald G. Fleming. 176, 1113 (1968)

GOTOW, K.
Single-Proton Emission Following Positive Pion Absorption in Carbon—T. R. Witten, M. Blecher, and K. Gotow. 174, 1166 (1968)

GOTSMAN, E.
Kinematical Singularities and Zeros for the Reaction $\gamma N \to VN$—E. Gotsman and U. Maor. 171, 1495 (1968)

GOUGH, Richard A.
Alpha Decay of the Isomers of $^{214}$Fr—David F. Torgerson, Richard A. Gough, and Ronald D. Macfarlane. 174, 1494 (1968)

GOULARD, B.
Dipole States in $Sr^{88}$—B. Goulard, T. A. Hughes, and S. Fallieros. 176, 1345 (1968)

GRAEBNER, J. E.
de Haas–van Alphen Effect in Antiferromagnetic Chromium—J. E. Graebner and J. A. Marcus. 175, 659 (1968)

GRAHAM, R. H.
Vector and Axial-Vector Meson Dominance in the $K_{3\pi}$ Decays—R. H. Graham and S. K. Yun. 171, 1550 (1968)

GRANATO, A. V.
Second- and Third-Order Elastic Constants of Alkali Metals—Tetsuro Suzuki, A. V. Granato, and J. F. Thomas, Jr. 175, 766 (1968)

GRANT, R. W.
Magnetic and Crystallographic Transitions in the $\alpha$-$Mn_2O_3$–$Fe_2O_3$ System—R. W. Grant, S. Geller, J. A. Cape, and G. P. Espinosa. 175, 686 (1968)

GRAY, T. J.
Elastic and Inelastic Scattering of $^3$He by $^{12}$C, 12.0-18.0 MeV—H. T. Fortune, T. J. Gray, W. Trost, and N. R. Fletcher. 173, 1002 (1968)

GRAY, W. S.
Semidirect $T$-Forbidden Reaction $^{12}C(d, \alpha)^{10}B_{0^+}^*$, $T = 1$—J. Jänecke, T. F. Yang, R. M. Polichar, and W. S. Gray. 175, 1301 (1968)

GREEN, A. E. S.
Realistic $N$-$N$ One-Boson-Exchange Potentials—T. Ueda and A. E. S. Green. 174, 1304 (1968)
Low-Energy Properties of Realistic $N$-$N$ One-Boson-Exchange Potentials—Alexander Gersten and A. E. S. Green. 176, 1199 (1968)

GREEN, H. S.
Singularities of a Bethe-Salpeter Amplitude—H. S. Green and S. N. Biswas. 171, 1511 (1968)

GREEN, Melville S.
Generalized Scaling and the Critical Eigenvector in Ideal Bose Condensation—Martin J. Cooper and Melville S. Green. 176, 302 (1968)

GREENBERG, David F.
Current Algebra on the Mass Shell: Leptonic $K$ Decays—David F. Greenberg. 174, 1820 (1968)

GREENBERG, O. W.
Erratum: Symmetric Quark Model of Baryon Resonances—O. W. Greenberg and M. Resnikoff. [163, 1844 (1967)] 172, 1850 (1968)
Reanalysis of the Lowest-Mass Negative-Parity Baryon Resonances Using the Symmetric Quark Model—D. R. Divgi and O. W. Greenberg. 175, 2024 (1968)

GREENDALE, A. E.
Cumulative Fission Yield and Half-Life of $^{134}$Sb—A. A. Delucchi, A. E. Greendale, and P. O. Strom. 173, 1159 (1968)

GREENE, M. Wayne
Alpha-Particle Yields and Angular Distributions in the $O^{16}(Li^6,\alpha_0)F^{18}$ Reaction from 4.8 to 13.8 MeV—M. Wayne Greene. 176, 1204 (1968)

GREENE, R. L.
Impurity-Induced Optical Fluorescence in $MnF_2$—R. L. Greene, D. D. Sell, R. S. Feigelson, G. F. Imbusch, and H. J. Guggenheim. 171, 600 (1968)

GREENLEES, G. W.
Nuclear-Matter Radii from a Reformulated Optical Model—G. W. Greenlees, G. J. Pyle, and Y. C. Tang. 171, 1115 (1968)
Nuclear-Matter Sizes in the Tin Isotopic Sequence—Richard N. Boyd and G. W. Greenlees. 176, 1394 (1968)

GREENSTEIN, Howard
Theory of a Single-Mode Gas Laser—Howard Greenstein. 175, 438 (1968)

GREGORICH, David T.
Pomeranchuk Theorem for Partial Waves and Narrowing of Resonance Widths: The $\rho$ Meson—Bipin R. Desai and David T. Gregorich. 173, 1434 (1968)

GREGORY, E. H.
Interaction of Acoustic Phonons with Nuclear Spins in $KTaO_3$—E. H. Gregory. 171, 365 (1968)

GREIG, J. R.
Measurements of the Stark Broadening of Two Neutral Helium Lines in a Plasma—J. R. Greig, C. P. Lim, G. A. Moo-Young, G. Palumbo, and Hans R. Griem. 172, 148 (1968)

GRENIER, C. G.
Lattice Thermal Conductivity, Nernst-Ettinghausen Effect, and Specific Heat in Antimony at Low Temperature—R. S. Blewer, N. H. Zebouni, and C. G. Grenier. 174, 700 (1968)

GRIEM, Hans R.
Measurements of the Stark Broadening of Two Neutral Helium Lines in a Plasma—J. R. Greig, C. P. Lim, G. A. Moo-Young, G. Palumbo, and Hans R. Griem. 172, 148 (1968)
Improved Stark Profile Calculations for the Hydrogen Lines $H\alpha$, $H\beta$, $H\gamma$, and $H\delta$—P. Kepple and Hans R. Griem. 173, 317 (1968)

GRIFFITH, Richard W.
Scalar Density Terms, $K\pi$ and $KK$ Scattering Lengths, and a Symmetry-Breaking Parameter—Richard W. Griffith. 176, 1705 (1968)

GRIFFITHS, David
Radiative Pion Capture and the Pion-Nucleus Vertex Function—David Griffiths and C. W. Kim. 173, 1584 (1968)

GRIFFITHS, Robert B.
Free Energy of Interacting Magnetic Dipoles—Robert B. Griffiths. 176, 655 (1968)

GRIFFY, T. A.
Determination of the Pion Form Factor by Electroproduction of Pions—K. F. Lambrakos and T. A. Griffy. 175, 1948 (1968)

GRISMORE, R.
Charge-Exchange Scattering of $K^+$ Mesons from Beryllium at 0.97 BeV/$c$—J. Gezelter, G. L. Salmon, F. V. Murphy, G. K. O'Neill, and R. Grismore. 173, 1315 (1968)

GROBMAN, Warren D.
Conduction-Electron Exchange and the Local Pseudopotential Form Factors in the Alkali Metals—Warren D. Grobman. 171, 673 (1968)

GROFF, R. P.
Fluxoid Quantization and Field-Induced Depairing in a Hollow Superconducting Microcylinder—R. P. Groff and R. D. Parks. 176, 567 (1968)

GROSS, David J.
Electromagnetic Mass Differences and Regge Phenomenology—David J. Gross and Heinz Pagels. 172, 1381 (1968)

GROVES, D. J.
Measurement of the Coherent Neutron Scattering Amplitude of Deuterium, Mercury, and Fluorine by Mirror Reflection—W. Bartolini, R. E. Donaldson, and D. J. Groves. 174, 313 (1968)

GROVES, T. H.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

GRUBER, U.
Nuclear Levels in $^{142}$Pr—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)

GRUENBERG, L. W.
Effect of Orbital Quantization on the Critical Field of Type-II Superconductors—L. W. Gruenberg and L. Gunther. 176, 606 (1968)

GRUNER, Peter
Limitation of the Phonon Heat Conductivity by Edge-Dislocation Dipoles, Single Dislocations, and Normal Processes—Peter Gruner and Helmut Bross. 172, 583 (1968)

GRUNZWEIG-GENOSSAR, J.
Magnetic Properties of Uranium Compounds with Elements of the VA and VIA Groups. I. Compounds of UX Type—J. Grunzweig-Genossar, M. Kuznietz, and F. Friedman. 173, 562 (1968)

GRYPEOS, M. E.
Analysis of the $\Lambda\Lambda$ Hypernucleus $_{\Lambda\Lambda}C^{14}$—S. Ali, L. P. Kok, and M. E. Grypeos. 171, 1203 (1968)

GUGGENHEIM, H. J.
Impurity-Induced Optical Fluorescence in $MnF_2$—R. L. Greene, D. D. Sell, R. S. Feigelson, G. F. Imbusch, and H. J. Guggenheim. 171, 600 (1968)

Magnetic Properties of the Planar Antiferromagnet $Rb_2FeF_4$—G. K. Wertheim, H. J. Guggenheim, H. J. Levinstein, D. N. E. Buchanan, and R. C. Sherwood. 173, 614 (1968)

Vibronic Transitions of $Sm^{2+}$ and $Eu^{2+}$ in $SrF_2$ and their Zeeman Effect—E. Cohen and H. J. Guggenheim. 175, 354 (1968)

Long-Wavelength Optical Lattice Vibrations in Mixed $KMgF_3$-$KNiF_3$ Crystals—A. S. Barker, Jr., J. A. Ditzenberger, and H. J. Guggenheim. 175, 1180 (1968)

GUIRAGOSSIÁN, Z. G. T.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

GUNDZIK, M. G.
Threshold Electropion Production from Current Algebra and Partially Conserved Axial-Vector Current—A. M. Gleeson, M. G. Gundzik, and Jacob G. Kuriyan. 173, 1708 (1968)

GUNION, John F.
Connection between the Toller Quantum Number $M$ and the Small-$t$ Behavior of the Asymptotic $S$-Channel Helicity Amplitudes—John F. Gunion and H. M. Lipinski. 176, 2045 (1968)

GUNTHER, Leon
"Boltzmann-Statistics" without Statistics in the Classical Harmonic Lattice—Leon Gunther. 171, 210 (1968)

Effect of Orbital Quantization on the Critical Field of Type-II Superconductors—L. W. Gruenberg and L. Gunther. 176, 606 (1968)

GUPTA, K. C.
Current Algebra, Crossing Symmetry, and Unitarity for $s$-Wave $\pi\pi$ Scattering—K. Datta, K. C. Gupta, and V. S. Varma. 173, 1549 (1968)

Momentum-Dependent $K_{e4}$-Decay Form Factors—Ranabir Dutt, K. C. Gupta, and J. S. Vaishya. 175, 1884 (1968)

Virtual-Photon–Pion Scattering, Hard-Pion Current Algebra, and Dispersion Relations—K. C. Gupta and J. S. Vaishya. 176, 2125 (1968)

GUPTA, O. P.
Pseudopotentials in Alloys and the Calculation of the Residual Resistivity—O. P. Gupta. 174, 668 (1968)

GUPTA, R. P.
Positron Annihilation in Yttrium and Zirconium—R. P. Gupta and T. L. Loucks. 176, 848 (1968)

GUPTA, Rajendra P.
Specific Heat and Grüneisen $\gamma$ of Noble Metals—Rajendra P. Gupta. 174, 714 (1968)

GUPTA, Suraj N.
Supplementary Conditions in the Quantized Gravitational Theory—Suraj N. Gupta. 172, 1303 (1968)

GUPTA, V. K.
Consequences of a $QQ\bar{Q}$ Model for Meson-Baryon Processes—S. Das Gupta, V. K. Gupta, and A. N. Mitra. 172, 1482 (1968)

Existence of the Trineutron—Horace Jacob and V. K. Gupta. 174, 1213 (1968)

GUPTA, Y. M.
Sum Rules for Meson-Baryon Scattering from Asymptotic Symmetry Requirements—V. P. Seth, B. K. Agarwal, and Y. M. Gupta. 173, 1759 (1968)

GURALNIK, G. S.
Formal Breakdown of Lorentz Invariance in Two-Dimensional Field Theories—G. S. Guralnik and C. R. Hagen. 171, 1431 (1968)

GUTAY, L. J.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

GUTTMANN, Anthony J.
Determination of Critical Behavior in Lattice Statistics from Series Expansions. I.—Anthony J. Guttmann, Barry W. Ninham, and Colin J. Thompson. 172, 554 (1968)

GYARMATI, B.
Shape of the Nuclear Symmetry Potential—J. Zimányi and B. Gyarmati. 174, 1112 (1968)

GYORGY, E. M.
Complex Susceptibility and Resonance Frequencies of Canted Antiferromagnets—F. B. Hagedorn and E. M. Gyorgy. 174, 540 (1968)

HAEBERLEN, U.
Coherent Averaging Effects in Magnetic Resonance—U. Haeberlen and J. S. Waugh. 175, 453 (1968)

HAEBERLI, W.
Charge-Exchange Collisions Between Helium Ions and Cesium Vapor in the Energy Range 1.5–25 keV—A. S. Schlachter, D. H. Loyd, P. J. Bjorkholm, L. W. Anderson, and W. Haeberli. 174, 201 (1968)

HAGEDORN, F. B.
Complex Susceptibility and Resonance Frequencies of Canted Antiferromagnets—F. B. Hagedorn and E. M. Gyorgy. 174, 540 (1968)

HAGEN, C. R.
Formal Breakdown of Lorentz Invariance in Two-Dimensional Field Theories—G. S. Guralnik and C. R. Hagen. 171, 1431 (1968)

HAHN, Yukap
Low-Energy Method in High-Energy Scatterings—Yukap Hahn. 174, 1135 (1968)
Many-Body Theory of Nuclear Reactions—Yukap Hahn. 174, 1168 (1968)
Theory of High-Energy Ion-Atom Collisions with Electron Exchanges—Yukap Hahn. 175, 197 (1968)

HAKIM, Rémi
Self-Consistent Homogeneous Isotropic Cosmological Models. I. Generalities—Rémi Hakim. 173, 1235 (1968)

HALBERT, M. L.
Proton-Proton Bremsstrahlung at 47 MeV—D. L. Mason, M. L. Halbert, and L. C. Northcliffe. 176, 1159 (1968)

HALBO, L.
Magnetoresistance of Undoped $n$-Type Gallium Arsenide at Low Temperatures—L. Halbo and R. J. Sladek. 173, 794 (1968)

HALE, Barbara
Modified Dispersion Relations and $\pi\pi$ Scattering—David J. George, Barbara Hale, and Arnold Tubis. 172, 1740 (1968)
Modified Phase Representation and Effects of Inelasticity in $N/D$ Calculation of $p$-Wave Pion-Pion Scattering—Barbara Hale and Arnold Tubis. 174, 2074 (1968)

HALL, W. F.
Mass Dependence of the Angular Distribution of Charged-Particle Emission from Crystals: Transition to the Classical Limit—R. E. De Wames, W. F. Hall, and G. W. Lehman. 174, 392 (1968)

HALL, W. S.
Characteristics of the Transition-State Spectra for $^{234}$U, $^{236}$U, and $^{240}$Pu from $(d,pf)$ and $(t,pf)$ Angular-Correlation Experiments—H. C. Britt, F. A. Rickey, Jr., and W. S. Hall. 175, 1525 (1968)

HALLER, Kurt
Subsidiary Condition in Quantum Electrodynamics—Kurt Haller and Leon F. Landovitz. 171, 1749 (1968)

HALOW, James
Application of the Cluster Variation Method to the $s$-$d$ Interaction Hamiltonian—James Halow, Tomoyasu Tanaka, and Tohru Morita. 175, 680 (1968)

HALPERN, Alvin M.
Hyperfine Structure of the $(p\mu p)^+$, $L=1$, Ortho, Bound State—Alvin M. Halpern. 174, 62 (1968)

HALPERN, F. R.
$O(4)$ Expansion of Off-Shell Scattering Amplitudes—W. R. Frazer, F. R. Halpern, H. M. Lipinski, and D. R. Snider. 176, 2047 (1968)

HALPERN, I.
Intensities and Angular Distributions of Ground-State Rotational Transitions Excited in $(\alpha,3n)$ and $(\alpha,4n)$ Reactions—C. F. Williamson, S. M. Ferguson, B. J. Shepherd, and I. Halpern. 174, 1544 (1968)

HALPERN, M. B.
Erratum: Construction of Solutions to Superconvergence Relations—D. Atkinson and M. B. Halpern. [166, 1724 (1968)] 171, 1834 (1968)
Canonical Representation of Sugawara's Theory—K. Bardakci and M. B. Halpern. 172, 1542 (1968)
Theories at Infinite Momentum—K. Bardakci and M. B. Halpern. 176, 1686 (1968)†

HALPERN, T. A.
Model Dependence of Corrections to the Fermi Function and $ft$ Values of Some $0^+ \rightarrow 0^+$ Super-Allowed $\beta$ Decays, and the Value of the Vector Coupling Constant—T. A. Halpern and B. Chern. 175, 1314 (1968)

HALPRIN, Arthur
Systematic Renormalization Procedure for the $N$-Quantum Approximation—Arthur Halprin. 172, 1495 (1968)

HAMBRO, Lars
Hyperfine Structure of the $2^3P$ Level in $He^3$—Lars Hambro. 175, 31 (1968)

HAMBURG
Photoproduction of Meson and Baryon Resonances at Energies up to 5.8 GeV—Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration. 175, 1669 (1968)

HAMILTON, J. H.
Evidence for a 0+ State in $^{68}$Zn Populated by $^{68}$Ga—H. K. Carter, J. H. Hamilton, A. V. Ramayya, and J. J. Pinajian. 174, 1329 (1968)

HAMMER, C. L.
Wave Equations on a Hyperplane—C. L. Hammer, S. C. McDonald, and D. L. Pursey. 171, 1349 (1968)

HANDLER, R.
Proton-Neutron Triple Scattering at 425 MeV. I.—S. C. Wright, D. Shawhan, L. Pondrom, S. Olsen, and R. Handler. 175, 1704 (1968)

HANKE, C. C.
Stopping Power of the Elements $Z=20$ Through $Z=30$ for 5–12-MeV Protons and Deuterons—H. H. Andersen, C. C. Hanke, H. Simonsen, H. Sørensen, and P. Vajda. 175, 389 (1968)

HANNA, S. S.
Lifetimes of Levels in $A=10$ Nuclei—T. R. Fisher, S. S. Hanna, D. C. Healey, and P. Paul. 176, 1130 (1968)
Lifetimes of Levels in $^{12}$C, $^{13}$C, and $^{13}$N—F. Riess, P. Paul, J. B. Thomas, and S. S. Hanna. 176, 1140 (1968)†

HANSEN, Jean-Pierre
Ground State of Solid Neon—Jean-Pierre Hansen. 172, 919 (1968)

HANSEN, Luisa F.
Two-Particle, Two-Hole States in $^{40}$K from the Study of the $^{40}$Ar($^3$He,$^3$H)$^{40}$K Reaction—J. J. Wesolowski, Luisa F. Hansen, and M. L. Stelts. 172, 1072 (1968)
Study of the Two-Body Force through the $(He^3,t)$ Charge-Exchange Reaction on $O^{17}$ and $O^{18}$—Luisa F. Hansen, Marion L. Stelts, Jose G. Vidal, J. J. Wesolowski, and V. A. Madsen. 174, 1155 (1968)

HANSEN, Wilford N.
Electromodulation of the Optical Properties of Gold—Wilford N. Hansen and Arnold Prostak. 174, 500 (1968)

HANSON, K.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)

HAPPER, W.
Light Shifts in the Alkali Atoms—B. S. Mathur, H. Tang, and W. Happer. 171, 11 (1968)
Hyperfine Structure and Lifetimes of the $4^2P_{3/2}$ and $5^2P_{3/2}$ States of $K^{39}$—Robert W. Schmieder, Allen Lurio, and W. Happer. 173, 76 (1968)

HARACZ, Richard D.
Two-Boson-Exchange Effects in Nucleon-Nucleon Scattering—Richard D. Haracz and Ravi D. Sharma. 176, 2013 (1968)

HARDY, J. C.
Carbon-10 and Mass Measurements for Light Nuclei—H. Brunnader, J. C. Hardy, and Joseph Cerny. 174, 1247 (1968)

HARDY, John R.
Infrared Absorption Properties of LiH, LiD Mixed Crystals —S. S. Jaswal and J. R. Hardy. 171, 1090 (1968)
Application of the Method of Lattice Statics to Interstitial Cu Atoms in Cu—John W. Flocken and John R. Hardy. 175, 919 (1968)
HARKAVY, Allan A.
Electron Spin Resonance of Undiluted Salts in the Parallel Configuration—Leonard Yarmus and Allan A. Harkavy. 173, 427 (1968)
HARLAN, R. A.
A $K^{\pi} = 0^{+}$ Band in $^{184}$W—K. T. Faler, R. R. Spencer, and R. A. Harlan. 175, 1495 (1968)
HARMS, B. C.
$\pi^- p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (I968)
HARPER, F. E.
The Mixed State in Superconducting Thin Films—F. E. Harper and M. Tinkham. 172, 441 (1968)
HARRINGTON, David R.
Multiple Scattering in the Quark Model—David R. Harrington and Antonio Pagnamenta. 173, 1599 (1968)
Three-Body Interaction Effects in High-Energy Scattering from Deuterons—David R. Harrington. 176, 1982 (1968)
HARRIS, A. Brooks
Dynamics of the Heisenberg Ferromagnet at Low Temperature—Richard Silberglitt and A. Brooks Harris. 174, 640 (1968)
Observation of Pair Interaction between Ortho Molecules in Solid $H_2$—A. Brooks Harris, Larry I. Amstutz, Horst Meyer, and Samuel M. Myers. 175, 603 (1968)
Energy Width of Spin Waves in the Heisenberg Ferromagnet —A. Brooks Harris. 175, 674 (1968)
HARRIS, Frank E.
Atomic Hyperfine Structure. I. Polarization Wave Functions for the Ground States of B, C, N, O, and F.—Henry F. Schaefer III, Richard A. Klemm, and Frank E. Harris. 176, 49 (1968)
HARRIS, W. R.
Elastic Scattering of 1- to 2.7-MeV Protons by $C^{14}$—W. R. Harris and J. C. Armstrong. 171, 1230 (1968)
Beta Decay of $N^{16}$ to the 6.05-MeV State of $O^{16}$—E. K. Warburton, W. R. Harris, and D. E. Alburger. 175, 1275 (1968)
HARRISON, J. P.
Study of an Impurity Mode Using Specific-Heat Measurements—J. P. Harrison, P. P. Peressini, and R. O. Pohl. 171, 1037 (1968)
HARRISON, W. C.
$\pi^- p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)
HARTE, John
Asymptotic Vertex Function in a Crossing-Symmetric Bootstrap Model of the Hadrons—John Harte. 171, 1825 (1968)
Possible Enhancement of Two-Photon-Exchange Effects in Large-Momentum-Transfer Electron-Proton Scattering—John Harte. 171, 1832 (1968)
HARTMAN, R. L.
Spin Relaxation via Low-Lying Energy Level of $Fe^{2+}$ in MgO—E. L. Wilkinson, R. L. Hartman, and J. G. Castle, Jr. 171, 299 (1968)
Tilt of the Electron Fermi Surface in Bi—R. D. Brown, R. L. Hartman, and S. H. Koenig. 172, 598 (1968)
HARTMANN, W. M.
Theory of the Vibrations of Dilute Alloys with Short-Range Order—W. M. Hartmann. 172, 677 (1968)
HASS, G.
Optical Properties of Platinum—A. Y-C. Yu, W. E. Spicer, and G. Hass. 171, 834 (1968)
HAUS, H. A.
Large-Scale Self-Trapping of Optical Beams in the Paraxial Ray Approximation—W. G. Wagner, H. A. Haus, and J. H. Marburger. 175, 256 (1968)
HAYDEN, Howard C.
Vibrational Excitation Effects on Charge-Transfer Processes Involving $H_2^+$ and $D_2^+$ Between 70 and 1000 eV—Howard C. Hayden and Robert C. Amme. 172, 104 (1968)
HAYES, Timothy M.
Ordering Energy and Effective Pairwise Interactions in a Binary Alloy of Simple Metals—Timothy M. Hayes, Harvey Brooks, and Arthur Bienenstock. 175, 699 (1968)
HAYMAKER, Richard W.
Variational Principles for Crossing-Symmetric Off-Shell Equations—Richard W. Haymaker and R. Blankenbecler. 171, 1581 (1968)
Stationary Expectation Values and Slopes of Daughter Regge Trajectories for the Bethe-Salpeter Equation—Rabinder N. Madan, Richard W. Haymaker, and R. Blankenbecler. 172, 1788 (1968)
HAYNE, G. S.
Measurements of $g_J$ Ratios for $Rb^{85}$, $Rb^{87}$, Hydrogen, and Deuterium, and of the Hyperfine Separation of Deuterium—G. S. Hayne, E. S. Ensberg, and H. G. Robinson. 171, 20 (1968)
Determination of $g$-Factor Ratios for Free $Rb^{85}$ and $Rb^{87}$ Atoms—C. W. White, W. M. Hughes, G. S. Hayne, and H. G. Robinson. 174, 23 (1968)
HEAD, M. E. M.
Decays of Odd-Parity Baryon Resonances—J. C. Carter and M. E. M. Head. 176, 1808 (1968)
HEADRICK, R. D.
Parity Conservation in the Reaction $T(d,n)He^4$—D. C. Bonar, C. W. Drake, R. D. Headrick, and V. W. Hughes. 174, 1200 (1968)
HEALEY, D. C.
Lifetimes of Levels in $A$=10 Nuclei—T. R. Fisher, S. S. Hanna, D. C. Healey, and P. Paul. 176, 1130 (1968)
HEEGER, A. J.
Ground State of the Magnetic Impurity Problem; Nuclear-Magnetic-Resonance Studies of Dilute Copper Alloys—A. J. Heeger, L. B. Welsh, M. A. Jensen, and G. Gladstone. 172, 302 (1968)
HEER, C. V.
Heat Capacity of $\alpha$-Manganese from 0.2 to 0.4°K—B. D. Martin and C. V. Heer. 173, 631 (1968)
Theory for the Measurement of the Earth's Velocity through the 3°K Cosmic Radiation—C. V. Heer and R. H. Kohl. 174, 1611 (1968)
HEIDELBERG
Photoproduction of Meson and Baryon Resonances at Energies up to 5.8 GeV—Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration. 175, 1669 (1968)
HEINRICHS, Jean
General Perturbation and Variational Methods for Responses to Time-Dependent Interactions in Quantum Mechanics—Jean Heinrichs. 172, 1315 (1968)
Theory of Electronic Transitions in Slow Atomic Collisions—Jean Heinrichs. 176, 141 (1968)
Erratum: General Perturbation and Variational Methods for Responses to Time-Dependent Interactions in Quantum Mechanics—Jean Heinrichs. [172, 1315 (1968)] 176, 2167 (1968)

HELLER, Leon
Soft-Photon Theorem for Bremsstrahlung in a Potential Model—Leon Heller. 174, 1580 (1968)

HENDERSON, Jerry D.
Capture and Elastic Scattering of Protons by $^{14}C$—Jerry D. Henderson, Emmett L. Hudspeth, and William R. Smith. 172, 1058 (1968)

HENDRY, Archibald W.
Harmonic-Oscillator Model for Baryons—David Faiman and Archibald W. Hendry. 173, 1720 (1968)

HENGEHOLD, R. L.
Ultraviolet Reflectivity Spectra of $CdS_{1-x}Se_x$ Single Crystals—R. L. Hengehold and C. R. Fraime. 174, 808 (1968)

HENISCH, H. K
Defect Energy-Level Structure of $PbI_2$ Single Crystals—A. E. Dugan and H. K. Henisch. 171, 1047 (1968)

HENRY, C. H.
Theory of Parametric Gain near a Lattice Resonance—C. H. Henry and C. G. B. Garrett. 171, 1058 (1968)

Dispersion in the Nonlinear Susceptibility of GaP near the Reststrahl Band—W. L. Faust, C. H. Henry, and R. H. Eick. 173, 781 (1968)

Electron-Capture ("Internal") Luminescence from the Oxygen Donor in Gallium Phosphide—P. J. Dean and C. H. Henry. 176, 928 (1968)

HENRY, G. Reading
Quantized Liquid Drop and Some Ground-State Nuclear Properties—G. Reading Henry. 176, 1126 (1968)

Distribution of Blackbody Cavity Radiation in a Moving Frame of Reference—G. R. Henry, R. B. Feduniak, J. E. Silver, and M. A. Peterson. 176, 1451 (1968)

HENRY, Ronald J. W.
Polarization in Low-Energy Electron Scattering: Carbon and Nitrogen—Ronald J. W. Henry. 172, 99 (1968)

Polarization Potential in Low-Energy Electron-$H_2$ Scattering—Neal F. Lane and Ronald J. W. Henry. 173, 183 (1968)

HENSLEY, Eugene B.
Additive Coloration of Alkaline-Earth Chalcogenides—Eugene B. Hensley, Wirt C. Ward, Bruce P. Johnson, and Roger L. Kroes. 175, 1227 (1968)

Additive Coloration of Calcium Oxide—Wirt C. Ward and Eugene B. Hensley. 175, 1230 (1968)

HENYEY, Frank S.
Threshold and Pseudothreshold Relations for Meson-Baryon Scattering—Frank S. Henyey. 171, 1509 (1968)

HERBUT, Fedor
Antilinear Operators in Hartree-Bogolyubov Theory. I—Fedor Herbut and Milan Vujičić. 172, 1031 (1968)

HERMAN, Frank
Spectral Analysis of Photoemissive Yields in GaAs and Related Crystals—Frank Herman and W. E. Spicer. 174, 906 (1968)

HERMAN, P. T.
Some Remarks on Perturbation Theory and Critical Phenomena—P. T. Herman and J. R. Dorfman. 176, 295 (1968)

HERMAN, R.
Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)

HERMAN, Roger M.
Rare-Gas-Induced $gJ$ Shifts in the Ground States of Alkali Atoms—Roger M. Herman. 175, 10 (1968)

HERRING, Conyers
Gravitationally Induced Electric Field near a Conductor, and Its Relation to the Surface-Stress Concept—Conyers Herring. 171, 1361 (1968)

HERSCHBACH, K.
Comparison of Defects Injected into Platinum by Quenching and by Radiation Doping—J. J. Jackson and K. Herschbach. 173, 664 (1968)

HERZOG, G.
Study of the Particles Emitted from $Br^{75}$ Compound Nuclei Formed in Two Ways: $C^{12}+Cu^{63}$ and $O^{16}+Co^{59}$—J. M. D'Auria, M. J. Fluss, G. Herzog, L. Kowalski, J. M. Miller, and R. C. Reedy. 174, 1409 (1968)

HESSER, James E.
Radiative Lifetimes from Ultraviolet Lines of Ne I, Ne II, and Ne III—James E. Hesser. 174, 68 (1968)

HETHERINGTON, J. H.
Formation of Nonlocalized Vacancies in bcc $He^3$—J. H. Hetherington. 176, 231 (1968)

HEWITT, R. R.
Nuclear Magnetic Resonance in Dilute Alloys of Indium-Lead and Indium-Tin—W. T. Anderson, Jr., F. C. Thatcher, and R. R. Hewitt. 171, 541 (1968)

HILL, D. E.
Free-Carrier and Exciton Recombination Radiation in GaAs—M. A. Gilleo, P. T. Bailey, and D. E. Hill. 174, 898 (1968)

HILL, D. G.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

HILL, Roger C.
General Form of Representations of the Current Algebra in the Two-Quark Model—Roger C. Hill. 172, 1521 (1968)

HINRICHSEN, P. F.
Energy Levels in $^{89}Y$—P. F. Hinrichsen, S. M. Shafroth, and D. M. Van Patter. 172, 1134 (1968)

HINTZ, Norton M.
Analysis of Two-Neutron ($L=0$) Transfer Cross Sections for Calcium and Nickel—B. F. Bayman and Norton M. Hintz. 172, 1113 (1968)

HIRD, B.
Analysis of the $C^{12}(p,\alpha)B^9$ Reaction at 44.5 MeV—T. Y. Li and B. Hird. 174, 1130 (1968)

HIRSHFELD, A. C.
Vertex-Strength-Algebra Treatment of Vector-Meson Photoproduction—A. C. Hirshfeld and L. P. Horwitz. 175, 1865 (1968)

HO, James C.
Low-Temperature Specific Heat of Face-Centered Cubic Ni-Co Alloys—James C. Ho and R. Viswanathan. 172, 705 (1968)

HOBBIE, Russell K.
Sequential Reactions from $Li^6$ on $Be^9$—Ramanathan Jambunathan and Russell K. Hobbie. 172, 1065 (1968)

HOBSON, Arthur
Exact Classical Nonequilibrium Statistical-Mechanical Analysis of the Finite Ideal Gas—Arthur Hobson and David N. Loomis. 173, 285 (1968)

HOFFMAN, D. C.
Beta Decay of $^{141}Ce$—D. C. Hoffman, F. O. Lawrence, and W. R. Daniels. 172, 1239 (1968)

HOFSTADTER, R.
Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)

HOLLAND, C. H.
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)

HOLLAND, R. E.
Effects Seen in the Passage of Positively Charged Ions through Single Crystals—R. E. Holland and D. S. Gemmell. 173, 344 (1968)
HOLMES, L.
Investigation of Magnetic Interactions in $TbAlO_3$ by Optical Spectroscopy—S. Hüfner, L. Holmes, F. Varsanyi, and L. G. Van Uitert. 171, 507 (1968)
HOLMES, R. R.
Electronic Energy States of Dislocations in CdS-Type Semiconductors—R. R. Holmes and C. Elbaum. 173, 803 (1968)
HOLMGREN, H. D.
The $C^{13}[He^3,Be^8(g.s.)]Be^8(g.s.)$ Reaction—K. S. Jayaraman and H. D. Holmgren. 172, 1015 (1968)
$Be^9(p,p\alpha)He^5$ Reaction at 57 MeV—P. G. Roos, H. G. Pugh, Mahavir Jain, H. D. Holmgren, Martin Epstein, and C. A. Ludemann. 176, 1246 (1968)
HOLSTEIN, Barry R.
$\Delta I=\frac{1}{2}$ Rule in Current-Current Models of *CP* Violation—Barry R. Holstein. 171, 1668 (1968)
HOLT, E. H.
Shear Stabilization of a Collision-Dominated Plasma—J. F. Reynolds and E. H. Holt. 175, 205 (1968)
HOLTON, W. C.
Paramagnetic-Resonance Studies of Rare-Earth Impurities in II-VI Compounds—R. K. Watts and W. C. Holton. 173, 417 (1968)
HOLYNSKI, R.
Experimental Tests of Cascade Theory at High Energies—R. Holynski, W. V. Jones, and K. Pinkau. 176, 1661 (1968)
HOMMA, S.
Wide-Angle Electron-Positron Pair Production. K. J. Cohen, S. Homma, D. Luckey, and L. S. Osborne. 173, 1339 (1968)
HONIG, J. M.
Electrical Properties of $Ti_2O_3$ Single Crystals—J. M. Honig and T. B. Reed. 174, 1020 (1968)
HOPFIELD, J. J.
Optical Absorption and Energy Loss in Sodium in the Hartree Approximation—E-Ni Foo and J. J. Hopfield. 173, 635 (1968)
Spin-Flip Raman Scattering in Cadmium Sulfide—D. G. Thomas and J. J. Hopfield. 175, 1020 (1968)
HOPKE, P. K.
Decay of $Ho^{163}$—P. K. Hopke, J. S. Evans, and R. A. Naumann. 171, 1290 (1968)
HOPKINS, D. C.
Neutron Diffraction and Susceptibility Study of Dilute La-Rare-Earth Alloys—D. K. Finnemore, L. J. Williams, F. H. Spedding, and D. C. Hopkins. 176, 712 (1968)
HORNER, Heinz
Shape-Dependent Thermodynamic Quantities in Magnetic Systems with Dipole Interaction—Heinz Horner. 172, 535 (1968)
HORNREICH, R. M.
Theory of Gyrotropic Birefringence—R. M. Hornreich and S. Shtrikman. 171, 1065 (1968)
HORWITZ, L. P.
Vertex-Strength-Algebra Treatment of Vector-Meson Photoproduction—A. C. Hirshfeld and L. P. Horwitz. 175, 1865 (1968)
HOUSLEY, R. M.
Mössbauer Faraday Effect—R. M. Housley and U. Gonser. 171, 480 (1968)
HOWARD, Donald G.
Lattice-Dynamical Properties of $Fe^{57}$ Impurity Atoms in Pt, Pd, and Cu from Precision Measurements of Mössbauer Fractions—Rudi H. Nussbaum, Donald G. Howard, Wilbur L. Nees, and Charles F. Steen. 173, 653 (1968)
HOWARD, W. E.
Optical and Electrical Properties and Band Structure of GeTe and SnTe—R. Tsu, W. E. Howard, and L. Esaki. 172, 779 (1968)
HOY, Gilbert R.
Magnetically Induced Quadrupole Interactions in $FeCr_2S_4$—Gilbert R. Hoy and K. P. Singh. 172, 514 (1968)
HSUAN, Hulbert C. S.
Nonlinear Effects in Plasma Resonance—Hulbert C. S. Hsuan. 172, 137 (1968)
HUANG, H. W.
Chiral Dynamics for High-Spin Baryons and an Application to Double-Pion Photoproduction—H. W. Huang. 174, 1799 (1968)
HUANG, J. C.
Quasars and Quarks—J. C. Huang and T. W. Edwards. 171, 1331 (1968)
HUANG, J. W.
Absorption Spectrum of Optically Pumped $Al_2O_3:Cr^{3+}$—J. W. Huang and H. W. Moos. 173, 440 (1968)
HUANG, Kerson
Large-Angle Proton-Proton Scattering and the Pomeranchuk Trajectory—Kerson Huang and Stephen Pinsky. 174, 1915 (1968)
HUANG, S.
Precision Measurement of Anisotropy in the Upper Critical Field of Superconducting Niobium—D. E. Farrell, B. S. Chandrasekhar, and S. Huang. 176, 562 (1968)
HUDIS, J.
Production of $^7Be$, $^{22}Na$, and $^{24}Na$ Fragments from Heavy Elements at 3, 10, and 30 GeV—J. Hudis and S. Tanaka. 171, 1297 (1968)
Production of Neon-24 and Sodium-24 in the 1–3-GeV Proton Bombardment of Copper, Silver, Gold, and Uranium Targets—J. Hudis. 171, 1301 (1968)
HUDSPETH, Emmett L.
Capture and Elastic Scattering of Protons by $^{14}C$—Jerry D. Henderson, Emmett L. Hudspeth, and William R. Smith. 172, 1058 (1968)
HUEBENER, R. P.
Thermoelectric Power of Aluminum and Dilute Aluminum Alloys—R. P. Huebener. 171, 634 (1968)
Lattice Heat Conductivity in Annealed and Quenched Gold-Platinum Alloys—C. van Baarle and R. P. Huebener. 172, 699 (1968)
HUFFMAN, G. P.
Electronic Component of Dislocation Drag in Metals—G. P. Huffman and N. Louat. 176, 773 (1968)
HÜFNER, Jörg
Shell Model in the Continuum—Application to the Four-Nucleon System—Jörg Hüfner and C. M. Shakin. 175, 1350 (1968)
Use of a Truncated Hilbert Space in Nuclear Reaction Calculations—Jörg Hüfner and R. H. Lemmer. 175, 1394 (1968)
HÜFNER, S.
Investigation of Magnetic Interactions in $TbAlO_3$ by Optical Spectroscopy—S. Hüfner, L. Holmes, F. Varsanyi, and L. G. Van Uitert. 171, 507 (1968)
Mössbauer Effect in Europium Alloys—S. Hüfner and J. H. Wernick. 173, 448 (1968)
HUGHES, A. E.
Some Features of the Temperature Dependence of Infrared Absorption by Localized Vibrational Modes—A. E. Hughes. 173, 860 (1968)
HUGHES, R. H.
Electron Capture into the $n=3$ States of H by Fast $H^+$ Impact on $N_2$—R. H. Hughes, B. M. Doughty, and A. R. Filippelli. 173, 172 (1968)

HUGHES, T. A.
Dipole States in $Sr^{88}$—B. Goulard, T. A. Hughes, and S. Fallieros. 176, 1345 (1968)
HUGHES, V. W.
Parity Conservation in the Reaction $T(d,n)He^4$—D. C. Bonar, C. W. Drake, R. D. Headrick, and V. W. Hughes. 174, 1200 (1968)
HUGHES, W. M.
Determination of $g$-Factor Ratios for Free $Rb^{85}$ and $Rb^{87}$ Atoms—C. W. White, W. M. Hughes, G. S. Hayne, and H. G. Robinson. 174, 23 (1968)
HUIZENGA, J. R.
Structure of the Fission Transition Nucleus $U^{235}$—A. N. Behkami, J. H. Roberts, W. Loveland, and J. R. Huizenga. 171, 1267 (1968)
Nuclear Pairing Energy of Transition Nucleus $Pu^{240}$—J. R. Huizenga, A. N. Behkami, J. W. Meadows, Jr., and E. D. Klema. 174, 1539 (1968)
HUMBLE, S.
Process $\pi^-p \to \pi^+\pi^-n$ near Threshold—S. Humble and T. D. Spearman. 171, 1724 (1968)
$T=0$, $J=0^+$ Pion-Pion Interaction—G. W. Ellison and S. Humble. 173, 1563 (1968)
HUNTINGTON, H. B.
Structure-Factor Approach to Migration Energy of Interstitials—Michael D. Feit and H. B. Huntington. 172, 580 (1968)
HURD, C. M.
Hall Coefficients of Cu, Ag, and Au in the Range 4.2–300°K—J. E. A. Alderson, T. Farrell, and C. M. Hurd. 174, 729 (1968)
Anisotropic Relaxation Times and the Hall Coefficients of α-Phase Alloys of the IB Metals—R. D. Barnard, J. E. A. Alderson, T. Farrell, and C. M. Hurd. 176, 761 (1968)
HURRELL, J. P.
Optical Phonons of Yttrium Aluminum Garnet—J. P. Hurrell, S. P. S. Porto, I. F. Chang, S. S. Mitra, and R. P. Bauman. 173, 851 (1968)
HURST, R. P.
Fully Coupled Hartree-Fock Calculations of the Refractive Index. Dynamic Polarizability and Verdet Coefficients of Helium, Beryllium, and Neon—V. G. Kaveeshwar, Kwong T. Chung, and R. P. Hurst. 172, 35 (1968)
HURWITZ, H., Jr.
Voltage Fluctuations in a Diode—H. Hurwitz, Jr. 172, 207 (1968)
HUTCHINGS, M. T.
Magnetic Interactions between Rare-Earth Ions in Insulators. III. EPR Measurements of $Ce^{3+}$ Pair-Interaction Constants in $LaCl_3$—R. J. Birgeneau, M. T. Hutchings, and R. N. Rogers. 175, 1116 (1968)
Erratum: Magnetic Interactions between Rare-Earth Ions in Insulators. I. Accurate Electron-Paramagnetic-Resonance Determination of $Gd^{3+}$ Pair-Interaction Constants in $LaCl_3$—M. T. Hutchings, R. J. Birgeneau, and W. P. Wolf. [168, 1026 (1968)] 176, 1112 (1968)
HWANG, C. J.
Calculation of the Deformation Energy of a Schottky Defect in Germanium—C. J. Hwang and L. A. K. Watt. 171, 958 (1968)
HYDE, Earl K.
New Isotopes of Thorium Studied with an Improved Helium-Jet Recoil Transport Apparatus—Kalevi Valli and Earl K. Hyde. 176, 1377 (1968)
IALONGO, G.
Angular Distribution of the Outgoing Electrons in Electronic Ionization—A. E. Glassgold and G. Ialongo. 175, 151 (1968)
IBARRA, H.
Neutron Diffraction by Liquid Zinc—B. A. Dasannacharya, Q. O. Navarro, H. Ibarra, S. Chatraphorn, and G. B. Lee. 173, 241 (1968)
ICHIMARU, Setsuo
Kinetic Equations for Turbulent Plasmas. I. Quasilinear Theory—Setsuo Ichimaru. 174, 289 (1968)
Kinetic Equations for Turbulent Plasmas. II. Fluctuation Spectrum—Setsuo Ichimaru. 174, 300 (1968)
IKEDA, Kiyomi
Hindrance Factors for Beta Decays of Heavy Nuclei—Hiroyasu Ejiri, Kiyomi Ikeda, and Jun-Ichi Fujita. 176, 1277 (1968)
IMBUSCH, G. F.
Impurity-Induced Optical Fluorescence in $MnF_2$—R. L. Greene, D. D. Sell, R. S. Feigelson, G. F. Imbusch, and H. J. Guggenheim. 171, 600 (1968)
IMRIE, C. A.
Search for the Electroproduction of the $N$ (1470) Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)
IMRIE, D.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for the Electroproduction of the $N'$(1470) Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)
INCE, W. J.
Antiferromagnetic Domains in $RbMnF_3$—W. J. Ince and A. Platzker. 175, 650 (1968)
ING, S. W., Jr.
Photogeneration of Carriers in Vitreous Selenium—D. M. Pai and S. W. Ing, Jr. 173, 729 (1968)
INGALLS, R.
Quadrupolar Hyperfine Anisotropy in $Fe(NH_4SO)_2 \cdot 6H_2O$ and Its Comparison with the Magnetic Susceptibility—R. Ingalls, K. Ono, and Louis Chandler. 172, 295 (1968)
INGBER, Lester
Nuclear Forces—Lester Ingber. 174, 1250 (1968)
INOKUTI, Mitio
Total Cross Sections for Inelastic Scattering of Charged Particles by Atoms and Molecules. II. Negative Hydrogen Ion—Mitio Inokuti and Yong-Ki Kim. 173, 154 (1968)
Generalized Oscillator Strengths of the Helium Atom. I—Yong-Ki Kim and Mitio Inokuti. 175, 176 (1968)
IORI, I.
Theoretical Calculations of Statistical Heavy-Ion Reactions—E. Gadioli, I. Iori, and L. Zetta. 174, 1140 (1968)
IRVIN, J. C.
$\Delta_1$ Conduction-Band Minimum of Ge from High-Pressure Studies on $p$-$n$ Junctions—A. Jayaraman, B. B. Kosicki, and J. C. Irvin. 171, 836 (1968)
ISHIDA, Shin
Static $SU(6)$ and Fundamental Substitution—Shin Ishida and P. Roman. 172, 1684 (1968)
ISIHARA, A.
Correlation Functions in Ring-Diagram Approximation—A. Isihara. 172, 166 (1968)

ISIN, Acar
Experiments with Tunnel Junctions Using Ferromagnetic Metals—J. E. Christopher, R. V. Coleman, Acar Isin, and R. C. Morris. 172, 485 (1968)

IWASAKI, Yoichi
$O(4)$ Symmetry in Feynman Amplitudes—Yoichi Iwasaki. 173, 1608 (1968)

IYER, R. H.
Ternary Fission of $U^{235}$ Induced by Intermediate-Energy Helium Ions—R. H. Iyer and J. W. Cobble. 172, 1186 (1968)

JACKEL, George S.
Electron Spin Resonance of Free Radicals Formed from Group-IV and Group-V Hydrides in Inert Matrices at Low Temperature—George S. Jackel and Walter Gordy. 176, 443 (1968)
Matrix Perturbations of the ESR of Trapped H, N, P, and As Atoms at 4.2°K—George S. Jackel, William H. Nelson, and Walter Gordy. 176, 453 (1968)

JACKIW, R.
Low-Energy-Theorem Approach to Single-Particle Singularities in the Presence of Massless Bosons—R. Jackiw and L. Soloviev. 173, 1485 (1968)
Stress-Tensor–Current Commutators, Electromagnetic and Weak Corrections to Current Commutators, and Sum Rules—R. Jackiw. 175, 2058 (1968)

JACKSON, A. D., Jr.
Spins and Nuclear Moments of $Sb^{115}$, $Sb^{117}$, $Sb^{118}$, $Sb^{119}$, and $Sb^{120}$—A. D. Jackson, Jr., E. H. Rogers, Jr., and G. J. Garrett. 175, 65 (1968)

JACKSON, Daphne F.
Scattering of Medium-Energy Alpha Particles. I. Phenomenological Analysis of Elastic Scattering—Daphne F. Jackson and C. G. Morgan. 175, 1402 (1968)

JACKSON, J. D.
Factorization, Kinematic Singularities, and Conspiracies—Farzam Arbab and J. D. Jackson. 176, 1796 (1968)

JACKSON, J. J.
Comparison of Defects Injected into Platinum by Quenching and by Radiation Doping—J. J. Jackson and K. Herschbach. 173, 664 (1968)

JACKSON, Jane C.
Single-Parameter Fit to Meson-Nucleon Forward Reactions—Jane C. Jackson. 174, 2098 (1968)

JACOB, Horace
Existence of the Trineutron—Horace Jacob and V. K. Gupta. 174, 1213 (1968)

JACOB, Richard J.
Possible Classification of Exchange-Degenerate Trajectories—Akbar Ahmadzadeh and Richard J. Jacob. 176, 1719 (1968)

JACOBS, A. E.
Experimental Test of the Theory of the Proximity Effect in Superconductors—A. E. Jacobs and D. M. Ginsberg. 175, 569 (1968)

JACOBS, E.
Positron Decays of $^{38}$Ca and $^{38}$K—R. W. Kavanagh, A. Gallmann, E. Aslanides, F. Jundt, and E. Jacobs. 175, 1426 (1968)

JACOBS, Matthew A.
Conspirators and Daughters in Unequal-Mass, Nonzero-Spin Scattering—Matthew A. Jacobs and Mark H. Vaughn. 172, 1677 (1968)

JAFFE, Arthur
A $\lambda\varphi^4$ Quantum Field Theory Without Cutoffs. I. James Glimm and Arthur Jaffe. 176, 1945 (1968)

JAHNS, M. F.
Polarization in $^{12}C(\vec{p},p)^{12}C$—G. E. Terrell, M. F. Jahns, M. R. Kostoff, and E. M. Bernstein. 173, 931 (1968)

JAIN, Mahavir
$Be^9(\vec{\gamma},p_0)He^5$ Reaction at 57 MeV—P. G. Roos, H. G. Pugh, Mahavir Jain, H. D. Holmgren, Martin Epstein, and C. A. Ludemann. 176, 1246 (1968)

JAIN, P. L.
Erratum: Ionization Loss at Relativistic Velocities—C. A. Nicoletta, P. J. McNulty, and P. L. Jain. [164, 1693 (1967)] 176, 2167 (1968)

JAIN, S. C.
Optical, Electron-Spin-Resonance, and Electrical Studies of Colloidal and $F$-Aggregate Centers in Highly Pure KCl Crystals. I. Colloidal Centers—S. C. Jain and G. D. Sootha. 171, 1075 (1968)
Optical, Electron-Spin-Resonance, and Electrical Studies of Colloidal and $F$-Aggregate Centers in Highly Pure KCl Crystals. II. $F$-Aggregate Centers—S. C. Jain and G. D. Sootha. 171, 1083 (1968)
Optical, Electrical, and EPR Studies of KBr Crystals Doped with Cadmium—S. C. Jain and S. Radhakrishna. 172, 972 (1968)

JAMBUNATHAN, Ramanathan
Sequential Reactions from $Li^6$ on $Be^9$—Ramanathan Jambunathan and Russell K. Hobbie. 172, 1065 (1968)

JAMES, L. W.
Location of the $L_1$ and $X_3$ Minima in GaAs as Determined by Photoemission Studies—L. W. James, R. C. Eden, J. L. Moll, and W. E. Spicer. 174, 909 (1968)

JAMES, P. B.
Sum-Rule Constraints on Baryon Regge Trajectories—P. B. James. 172, 1602 (1968)

JAMIESON, P. B.
Atomic Displacement Relationship to Curie Temperature and Spontaneous Polarization in Displacive Ferroelectrics—S. C. Abrahams, S. K. Kurtz, and P. B. Jamieson. 172, 551 (1968)

JÄNECKE, J.
Semidirect $T$-Forbidden Reaction $^{12}C(d,\alpha)^{10}B_0^*$, $T=1$—J. Jänecke, T. F. Yang, R. M. Polichar, and W. S. Gray. 175, 1301 (1968)

JANIS, Allen I.
Static, Axially Symmetric Point Horizons—Jeffrey Winicour, Allen I. Janis, and Ezra T. Newman. 176, 1507 (1968)

JASNOW, David
High-Temperature Critical Indices for the Classical Anisotropic Heisenberg Model—David Jasnow and Michael Wortis. 176, 739 (1968)
Critical Behavior of the Ising, $XY$, and Heisenberg Ferromagnets on the $B$-Site Spinel Lattice—David Jasnow and M. A. Moore. 176, 751 (1968)

JASWAL, S. S.
Infrared Absorption Properties of LiH, LiD Mixed Crystals—S. S. Jaswal and J. R. Hardy. 171, 1090 (1968)

JAYARAMAN, A.
$\Delta_1$ Conduction-Band Minimum of Ge from High-Pressure Studies on $p$-$n$ Junctions—A. Jayaraman, B. B. Kosicki, and J. C. Irvin. 171, 836 (1968)
Conduction-Band Structure of GaSb from Pressure Experiments to 50 kbar—B. B. Kosicki, A. Jayaraman, and William Paul. 172, 764 (1968)

JAYARAMAN, K. S.
The $C^{13}[He^3,Be^9(g.s.)]Be^9(g.s.)$ Reaction—K. S. Jayaraman and H. D. Holmgren. 172, 1015 (1968)

JEENER, J.
Measurement of the Nuclear Spin Diffusion Coefficient in $CaF_2$—G. W. Leppelmeier and J. Jeener. 175, 498 (1968)

JEFFREY, K. R.
Nuclear-Quadrupole-Resonance Study of Lattice Dynamics in $K_2PtCl_4$—K. R. Jeffrey and R. L. Armstrong. 174, 359 (1968)

JENSEN, M. A.
Ground State of the Magnetic Impurity Problem; Nuclear-Magnetic-Resonance Studies of Dilute Copper Alloys—A. J. Heeger, L. B. Welsh, M. A. Jensen, and G. Gladstone. 172, 302 (1968)

JESSE, William P.
Alpha-Particle Ionization in Argon-Methane Mixtures and the Energy Dependence of the Ion Pair-Formation Energy—William P. Jesse. 174, 173 (1968)

JETTE, A. Norman
**Theory of Polarization of Molecular Line Radiation Excited by Electron Impact—A. Norman Jette and Patrick Cahill. 176, 186 (1968)**

JHA, S.
**Levels of $^{130}$Xe Populated in $\beta$ Decay of $^{130}$I and $^{130}$Cs—Theodore E. Fessler, Glenn M. Julian, and S. Jha. 174, 1472 (1968)**

JHA, Sudhanshu S.
**Nonlinear Optical Susceptibilities in Group-IV and III-V Semiconductors—Sudhanshu S. Jha and N. Bloembergen. 171, 891 (1968)**

Optical Second-Harmonic Generation in Reflection from Media with Inversion Symmetry—N. Bloembergen, R. K. Chang, S. S. Jha, and C. H. Lee. 174, 813 (1968)

JOACHAIN, Charles J.
**High-Energy Hadron-Nucleus Collisions. I. Protons—Alfred S. Goldhaber and Charles J. Joachain. 171, 1566 (1968)**

JOHN, Joseph
Optical-Model Analysis of Alpha-Particle Scattering by $^{40}$Ca from 12 to 18 MeV—C. P. Robinson, J. P. Aldridge, Joseph John, and R. H. Davis. 171, 1241 (1968)

JOHNSON, Bruce P.
**Additive Coloration of Alkaline-Earth Chalcogenides—Eugene B. Hensley, Wirt C. Ward, Bruce P. Johnson, and Roger L. Kroes. 175, 1227 (1968)**

JOHNSON, D. P.
Low-Temperature Anharmonicity in $FeCl_2$—D. P. Johnson and J. G. Dash. 172, 983 (1968)

JOHNSON, J. A.
**Pion Production and Elastic Scattering in Antiproton-Proton Collisions at 6.94 BeV/$c$—T. Ferbel, J. A. Johnson, H. I. Kraybill, J. Sandweiss, and H. D. Taft. 173, 1307 (1968)**

JOHNSON, O. W.
Defects in Rutile. I. Electron Paramagnetic Resonance of Interstitially Doped $n$-Type Rutile—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1091 (1968)

Defects in Rutile. II. Diffusion of Interstitial Ions—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1099 (1968)

**Defects in Rutile. III. Optical and Electrical Properties of Impurities and Charge Carriers—O. W. Johnson, W. D. Ohlsen, and Paul I. Kingsbury, Jr. 175, 1102 (1968)**

JOHNSON, P. B.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

JOHNSON, R. A.
Kinetic Study of Vacancy Clustering and Annealing in Metals—R. A. Johnson. 174, 684 (1968)

JOHNSON, R. C.
**Argand-Diagram Loops and Regge Poles—P. D. B. Collins, R. C. Johnson, and G. G. Ross. 176, 1952 (1968)**

JOHNSON, Robert E.
**Concept of Ideal Collective Coordinate as the Foundation for a Phenomenological Theory of Nuclear Collective Motion: Basic Ideas and Relation to Other Phenomenological Methods—Abraham Klein, R. M. Dreizler, and Robert E. Johnson. 171, 1216 (1968)**

**Application of the Concept of Ideal Collective Coordinate to a Simple Microscopic Model—Abraham Klein and Robert E. Johnson. 171, 1224 (1968)**

JOHNSON, W. T. K.
Comparison of Experiment and Theory for Nuclear Excitation in $^{115}$In by Threshold-Energy Electrons—B. T. Chertok and W. T. K. Johnson. 174, 1525 (1968)

JOHNSTON, D. R.
Zeeman Splitting of Vibronic Levels for Octahedral Actinide and Lanthanide Complexes, Free and in Crystals—R. A. Satten, D. R. Johnston, and E. Y. Wong. 171, 370 (1968)

JOINER, W. C. H.
Temperature Dependence of the Flux-Flow Resistance near $H_{c2}$ in Type-II Superconductors—Carl J. Axt and W. C. H. Joiner. 171, 461 (1968)

JONES, B. L.
**Effect of an External Radiation on the Energy Levels of an Electron System—B. L. Jones and M. Verschueren. 176, 42 (1968)**

JONES, C. Edward
Analyticity and Broken $O(4)$ Symmetry—J. B. Bronzan, C. Edward Jones, and P. K. Kuo. 175, 2200 (1968)

JONES, C. M.
**$^{136}$Xe($d,p$) and $^{136}$Xe($d,t$) Reactions—P. A. Moore, P. J. Riley, C. M. Jones, M. D. Mancusi, and J. L. Foster, Jr. 175, 1516 (1968)**

JONES, Gerald L.
Structure of Correlation Functions near the Critical Point—Gerald L. Jones. 171, 243 (1968)

JONES, H. F.
**Natural Zeros of Regge Residues—H. F. Jones and M. D. Scadron. 171, 1809 (1968)**

**Covariant $M$ Functions for Higher Spin—M. D. Scadron and H. F. Jones. 173, 1734 (1968)**

JONES, K. W.
Energy Levels of $^{46}$Sc—W. J. McDonald, J. T. Sample, D. M. Sheppard, G. M. Stinson, and K. W. Jones. 171, 1254 (1968)

Gamma Rays from the $Sc^{45}(p,p'\gamma)$ Reaction—C. Chasman, K. W. Jones, and R. A. Ristinen. 173, 1072 (1968)

JONES, Lorella
**Analyticity and the Daughter Structure of Conspiring Regge-Pole Families—Lorella Jones and Harvey K. Shepard. 175, 2117 (1968)**

JONES, P. B.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)

Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

JONES, R. C.
Fermi Surface of Cadmium: Radio-Frequency Size Effect—R. C. Jones, R. G. Goodrich, and L. M. Falicov. 174, 672 (1968)

JONES, R. V.
Magnetic Properties of $Ga_{2-x}Fe_xO_3$—B. F. Levine, C. H. Nowlin, and R. V. Jones. 174, 571 (1968)

JONES, W. V.
Experimental Tests of Cascade Theory at High Energies—R. Holynski, W. V. Jones, and K. Pinkau. 176, 1661 (1968)
JORDAN, Harry F.
Three-Particle Effects in the Pair Distribution Function for $He^4$ Gas—Harry F. Jordan and Lloyd D. Fosdick. 171, 128 (1968)
JORNA, S.
Statistical Theory of Nuclei—K. A. Brueckner, J. R. Buchler, S. Jorna, and R. J. Lombard. 171, 1188 (1968)
JOSEPH, D. W.
Current Commutation Relations in $R(11)$—L. L. Smalley and D. W. Joseph. 174, 1937 (1968)
JOSHI, K. P.
Effective Interaction for Light and Intermediate Nuclei—K. P. Joshi, G. K. Mehta, and Y. R. Waghmare. 176, 1154 (1968)
JOSHI, S. B.
Acoustoelectric Effect in Polar Semiconductors—V. V. Paranjape and S. B. Joshi. 174, 919 (1968)
JUDD, B. R.
Atomic Term Patterns—B. R. Judd. 173, 39 (1968)
Atomic $g$ Electrons—B. R. Judd. 173, 40 (1968)
Magnetic Parameters for the Configuration $f^3$—Hannah Crosswhite, H. M. Crosswhite, and B. R. Judd. 174, 89 (1968)
JULIAN, Glenn M.
Decay of $^{139}$La and $^{134}$La—Glenn M. Julian and Theodore E. Fessler. 172, 1208 (1968)
Levels of $^{130}$Xe Populated in $\beta$ Decay of $^{130}$I and $^{130}$Cs—Theodore E. Fessler, Glenn M. Julian, and S. Jha. 174, 1472 (1968)
JUNDT, F.
Positron Decays of $^{31}$Ca and $^{38}$K—R. W. Kavanagh, A. Gallmann, E. Aslanides, F. Jundt, and E. Jacobs. 175, 1426 (1968)
JUNG, Peter
Mössbauer Effect of $I^{127}$ and $Te^{125}$ in Iodine, Tellurium, and Antimony Compounds—Peter Jung and Werner Triftshäuser. 175, 512 (1968)
JURA, G.
Fermi Momentum of Aluminum from 0 to 100 kbar—J. J. Burton and G. Jura. 171, 699 (1968)
JURNEY, E. T.
Nuclear Levels in $^{142}$Pr—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)
KABASAKAL, Yurdanur
Hyperfine Structure of $^{67}$Ga and $^{72}$Ga—Vernon J. Ehlers, Yurdanur Kabasakal, Howard A. Shugart, and Orhan Tezer. 176, 25 (1968)
KABLER, M. N.
Recombination Luminescence from Self-Trapped Excitons in Ammonium Halide Crystals—M. J. Marrone and M. N. Kabler. 176, 1070 (1968)
KACSER, C.
Watson's Theorem When There Are Three Strongly Interacting Particles in the Final State—I. J. R. Aitchison and C. Kacser. 173, 1700 (1968)
KADANOFF, Leo P.
Anomalous Electrical Conductivity above the Superconducting Transition—Leo P. Kadanoff and George Laramore. 175, 579 (1968)
KADAR, G.
Magnetic Structures and Exchange Interactions in the Mn–Pt System—E. Krén, G. Kádár, L. Pál, J. Sólyom, P. Szabó, and T. Tarnóczi. 171, 574 (1968)
KAECK, J. A.
Electron-Spin Susceptibilities of the Liquid Binary Alkali Metal Alloys—J. A. Kaeck. 175, 897 (1968)
KAELIN, G.
Spin-Lattice Relaxation-Time Measurements on $Er^{3+}$-Doped Lanthanum Ethylsulfate—C. R. Viswanathan and G. Kaelin. 171, 992 (1968)
KAGA, H.
Third-Order Elastic Constants of Calcite—H. Kaga. 172, 900 (1968)
KAHN, Arnold H.
Polarons in Anisotropic Energy Bands—Arnold H. Kahn. 172, 813 (1968)
KAHN, David
Wave Coupling Across a Shock Wave in a Fully Ionized Gas—Samuel H. Francis and David Kahn. 172, 181 (1968)
KAISER, H. F.
Inelastic Electron Scattering from $^{24}$Mg at 180°—L. W. Fagg, W. L. Bendel, R. A. Tobin, and H. F. Kaiser. 171, 1250 (1968)
Inelastic Electron Scattering from $^{26}$Mg at 180°.—W. L. Bendel, L. W. Fagg, R. A. Tobin, and H. F. Kaiser. 173, 1103 (1968)
KAJANTIE, K.
Bounds for Coupling Constants in the Multi-Regge Model—K. Kajantie. 172, 1470 (1968)
Physical Region on the Plane of Two Invariant Momentum Transfers for a Reaction with Three Particles in the Final State—K. Kajantie and P. Lindblom. 175, 2203 (1968)
KALDOR, Uzi
Spin-Extended Wave Functions for First-Row Atoms—Uzi Kaldor. 176, 19 (1968)
Spin-Extended Wave Function for Atomic Sodium—Uzi Kaldor. 176, 71 (1968)
KALET, Ira J.
Low-Energy Compton Scattering by Arbitrary-Spin Targets—Ira J. Kalet. 176, 2135 (1968)
KALMA, A. H.
Photoconductivity Studies of Defects in Silicon: Divacancy-Associated Energy Levels—A. H. Kalma and J. C. Corelli. 173, 734 (1968)
KALVIUS, G. M.
Isomer Shift and Hyperfine Splittings of the 59.6-keV Mössbauer Resonance in $^{237}$Np—B. D. Dunlap, G. M. Kalvius, S. L. Ruby, M. B. Brodsky, and D. Cohen. 171, 316 (1968)
KAM, Z.
Accurate Numerical Method for Calculating Frequency Distribution Functions in Solids. III. Extension to Tetragonal Crystals—Z. Kam and G. Gilat. 175, 1156 (1968)
KAMAL, A. N.
Multiple Soft-Pion Production—A. N. Kamal. 171, 1556 (1968)
KANE, Evan O.
Critical-Point Structure in Photoelectric Emission Energy Distributions—Evan O. Kane. 175, 1039 (1968)
Band-Structure Effects and Many-Particle Scattering Corrections in the Far-Ultraviolet Spectra of Ge and Si—David Brust and Evan O. Kane. 176, 894 (1968)
KANE, G. L.
Interference of Kaon Resonances—G. L. Kane and H. S. Mani. 171, 1533 (1968)
Bootstrap Calculation of Vector-Meson–Baryon Coupling Constants—G. L. Kane and W. F. Palmer. 172, 1648 (1968)
Can the Parity of the $\Omega^-$ Be Measured?—G. L. Kane and Michael J. Moravcsik. 176, 1733 (1968)

KANE, J. W.
Coupling of Density and Spin Fluctuations to Quasiparticles in a Fermi Liquid—D. J. Amit, J. W. Kane, and H. Wagner. 175, 313 (1968)
Logarithmic Terms in the Specific Heat of a Normal Fermi Liquid—D. J. Amit, J. W. Kane, and H. Wagner. 175, 326 (1968)

KANE, W. R.
$Ba^{137}(n,\gamma)$ Reaction and Level Structure of $Ba^{138}$—M. A. J. Mariscotti, W. Gelletly, J. A. Moragues, and W. R. Kane. 174, 1485 (1968)

KANG, Ik-Ju
Angular Dependence of $2^3S$ Excitation of He by High-Energy Electron Impact—Ik-Ju Kang and Chan Kyoo Choi. 171, 123 (1968)

KANG, Kyungsik
Spectral-Function Sum Rules with Symmetry Breaking—Tomoya Akiba and Kyungsik Kang. 172, 1551 (1968)

KANG, Y. W.
$K^*(890)$ and $K^*(1420)$ Production in $K^-p$ Interactions at 4.57 BeV/$c$—Y. W. Kang. 176, 1587 (1968)

KAPLAN, J. I.
Erratum: Effective Magnetic Field in Metals—J. I. Kaplan and M. L. Glasser. [170, 649 (1968)] 173, 918 (1968)

KARPLUS, M.
Padé-Approximant Calculation of the Nonretarded van der Waals Coefficients for Two and Three Helium Atoms—K. T. Tang and M. Karplus. 171, 70 (1968)

KARPMAN, G.
$T$-Violation Effects and Final-State Interactions—G. Karpman, R. Leonardi, and F. Strocchi. 174, 1957 (1968)

KARRA, J. S.
Dynamic Polarization of Protons in Copper Tutton Salts (Dilute $CuK_4SO_4 \cdot 6H_2O$) and Their Spin-Lattice Relaxation Times—J. S. Karra, R. Clarkson, and T. Sato. 175, 479 (1968)

KARSHON, U.
Study of the $\Lambda$-$N$ System in Low-Energy $\Lambda$-$p$ Elastic Scattering—G. Alexander, U. Karshon, A. Shapira, G. Yekutieli, R. Engelmann, H. Filthuth, and W. Lughofer. 173, 1452 (1968)

KASHA, H.
Search for Heavy Triplets in Cosmic Rays—H. Kasha and R. J. Stefanski. 172, 1297 (1968)

KASHY, E.
Precise Energies of $^{40}Ca$ Levels—E. Kashy and J. L. Snelgrove. 172, 1124 (1968)

KASNER, W. H.
Temperature Dependence of the Electron - $O_2^+$-Ion Recombination Coefficient—W. H. Kasner and Manfred A. Biondi. 174, 139 (1968)

KATZ, J. Lawrence
Examination of the Thermal Variation of the Mean Square Atomic Displacements in Zinc and Evaluation of the Associated Debye Temperature—Earl F. Skelton and J. Lawrence Katz. 171, 801 (1968)

KAUFMAN, Leon
$\pi^-$-$^4He$ Inelastic and Capture Reactions Leading to Excited and Multineutron Final States—Leon Kaufman, Victor Perez-Mendez, and John Sperinde. 175, 1358 (1968)

KAUFMANN, William B.
Bootstrap Solutions of the Bethe-Salpeter Equation—William B. Kaufmann. 172, 1697 (1968)

KAUP, David J.
Klein-Gordon Geon—David J. Kaup. 172, 1331 (1968)

KAUS, Peter E.
Field-Theoretic Formulation of the Bootstrap Hypothesis—P. Kaus and F. Zachariasen. 171, 1597 (1968)
Crossing-Symmetric Rising Regge Trajectories—Shu-Yuan Chu, Gary Epstein, Peter E. Kaus, Richard C. Slansky, and Fredrik Zachariasen. 175, 2098 (1968)

KAUSHAL, N. N.
Fast-Photoneutron Spectra due to 55–85-MeV Photons—N. N. Kaushal, E. J. Winhold, P. F. Yergin, H. A. Medicus, and R. H. Augustson. 175, 1330 (1968)

KAVALOSKI, C. D.
Two-Neutron-Hole Configurations in $Pb^{206}$ from Isobaric Analog Measurements—Patrick Richard, Nelson Stein, C. D. Kavaloski, and J. S. Lilley. 171, 1308 (1968)

KAVANAGH, R. W.
Positron Decays of $^{39}Ca$ and $^{39}K$—R. W. Kavanagh, A. Gallmann, E. Aslanides, F. Jundt, and E. Jacobs. 175, 1426 (1968)

KAVEESHWAR, V. G.
Fully Coupled Hartree-Fock Calculations of the Refractive Index. Dynamic Polarizability and Verdet Coefficients of Helium, Beryllium, and Neon—V. G. Kaveeshwar, Kwong T. Chung, and R. P. Hurst. 172, 35 (1968)

KEATING, D. T.
Neutron Measurement of Clustering in the Alloy CuNi—B. Mozer, D. T. Keating, and S. C. Moss. 175, 868 (1968)

KEATING, P. N.
Dielectric Screening and the Phonon Spectra of Metallic and Nonmetallic Crystals—P. N. Keating. 175, 1171 (1968)

KEHOE, B.
Final States with Two or More Strange Particles from 4.25-BeV/$c$ $K^-p$ Interactions—G. S. Abrams, R. G. Glasser, B. Kehoe, B. Sechi-Zorn, and G. Wolsky. 175, 1697 (1968)
Low-Energy $\Lambda$-Proton Elastic Scattering—B. Sechi-Zorn, B. Kehoe, J. Twitty, and R. A. Burnstein. 175, 1735 (1968)

KEIL, Thomas H.
Quantum-Mechanical Description of Two Coupled Harmonic Oscillators—Lee E. Estes, Thomas H. Keil, and Lorenzo M. Narducci. 175, 286 (1968)

KELLY, Francis J.
Electroexcitation of the Giant Resonance in $^{12}C$—Francis J. Kelly and H. Überall. 175, 1235 (1968)

KELLY, Hugh P.
Optical-Potential Calculation of Electron-Hydrogen Singlet Scattering—Hugh P. Kelly. 171, 54 (1968)
Hyperfine Contact Interactions in Oxygen Calculated by Many-Body Theory—Hugh P. Kelly. 173, 142 (1968)

KELLY, Michael M.
New Theoretical Approach to Nuclear Heavy-Ion Scattering—Keith A. Brueckner, J. Robert Buchler, and Michael M. Kelly. 173, 944 (1968)

KELLY, W. H.
High-Resolution Gamma-Ray Spectroscopic Studies of the Decays of 2.6-h $Nd^{141g}$ and 60-sec $Nd^{141m}$—D. B. Beery, W. H. Kelly, and Wm. C. McHarris. 171, 1283 (1968)

KEMP, James C.
Faraday Rotation of the CaO $F$ Band and 3557 Å Zero-Phonon Peak—James C. Kemp, William M. Ziniker, James A. Glaze, and Jack C. Cheng. 171, 1024 (1968)

KEMPF, R. A.
Hyperfine Structure in the Millimeter Spectrum of Hydrogen Sulfide: Electric Resonance Spectroscopy on Asymmetric-Top Molecules—R. E. Cupp, R. A. Kempf, and J. J. Gallagher. 171, 60 (1968)

KENNEY, V. P.
Compilation of $\pi^-p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

KENNY, Brian G.
Spectrum Correction Factors in $\eta$, $K \to 3\pi$ Decay—Brian G. Kenny. 175, 2054 (1968)
Structure in $\eta$, $K \to 3\pi$ Decay—Brian G. Kenny. 176, 1735 (1968)
KENT, James J.
Isobaric-Analog Study of $^{90}$Zr—K. P. Lieb, James J. Kent, and C. Fred Moore. 175, 1482 (1968)
KEPPLE, P.
Improved Stark Profile Calculations for the Hydrogen Lines Hα, Hβ, Hγ, and Hδ—P. Kepple and Hans R. Griem. 173, 317 (1968)
KERN, Jean
Nuclear Levels in $^{142}$Pr—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)
KERNAN, W. J.
$K^-p$ Elastic Scattering at 4.6 GeV/$c$—L. S. Schroeder, R. A. Leacock, R. L. Wagstaff, and W. J. Kernan. 176, 1648 (1968)
KERR, William C.
Correlated Motions in Simple Classical Liquids—William C. Kerr. 174, 316 (1968)
KEYS, L. K.
High-Temperature Recovery of Tungsten after Neutron Irradiation—L. K. Keys, J. P. Smith, and J. Moteff. 176, 851 (1968)
KEYWORTH, G. A.
High-Resolution Study of Isobaric Analog Resonances in $^{23}$Na—G. A. Keyworth, P. Wilhjelm, G. C. Kyker, Jr., H. W. Newson, and E. G. Bilpuch. 176, 1302 (1968)
KHARE, S. P.
Photo-Ionization of the Hydrogen Molecule—S. P. Khare. 173, 43 (1968)
KHURI, N. N.
Sums of Direct-Channel Regge-Pole Contributions and Crossing Symmetry—N. N. Khuri. 176, 2026 (1968)
KIANG, D.
Superconvergence Relations and Possible New Resonances in Pion-Baryon Scattering—D. Kiang, W. C. Lin, R. Sugano, H. E. Lin, and Y. Nogami. 176, 2159 (1968)
KIBBLE, T. W. B.
Coherent Soft-Photon States and Infrared Divergences. II. Mass-Shell Singularities of Green's Functions—T. W. B. Kibble. 173, 1527 (1968)
Coherent Soft-Photon States and Infrared Divergences. III. Asymptotic States and Reduction Formulas—T. W. B. Kibble. 174, 1882 (1968)
Coherent Soft-Photon States and Infrared Divergences. IV. The Scattering Operator—T. W. B. Kibble. 175, 1624 (1968)
KIEFER, R. L.
Isomer Ratio of $Ce^{137m}$ to $Ce^{137g}$ Produced in Several Charged-Particle Reactions—R. L. Kiefer and K. Street, Jr. 173, 1202 (1968)
KILNER, J. R.
Charged Component of 1-GeV Electron Showers in Lead—D. J. Drickey, J. R. Kilner, and D. Benaksas. 171, 310 (1968)
KIM, C. W.
Radiative Pion Capture and the Pion-Nucleus Vertex Function—David Griffiths and C. W. Kim. 173, 1584 (1968)
KIM, S.
Spin-Parity Analysis of the Low-Mass (1.1–1.4 BeV) $K^+\pi$ System in $K^-p \to \overline{K}^{*0}\pi^-p$ at 5.5 BeV/$c$—J. C. Park and S. Kim. 174, 2165 (1968)
KIM, Shoon K.
Theory of Impurity-Induced Infrared Absorption—Robert S. Wilson, W. T. King, and Shoon K. Kim. 175, 1164 (1968)
KIM, Y. S.
Erratum: Perturbed Bound-State Poles in Potential Scattering. II—Y. S. Kim and Kashyap V. Vasavada. [150, 1236 (1966)] 172, 1849 (1968)
KIM, Y. W.
Conversion of $F_3^+$ Centers and Destruction of $R$ Centers in LiF with $R$ Light—K. L. Vander Lugt and Y. W. Kim. 171, 1096 (1968)
KIM, Yong-Ki
Total Cross Sections for Inelastic Scattering of Charged Particles by Atoms and Molecules. II. Negative Hydrogen Ion—Mitio Inokuti and Yong-Ki Kim. 173, 154 (1968)
Generalized Oscillator Strengths of the Helium Atom. I—Yong-Ki Kim and Mitio Inokuti. 175, 176 (1968)
KIMEL, J. D.
$\pi^-p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)
KING, W. T.
Theory of Impurity-Induced Infrared Absorption—Robert S. Wilson, W. T. King, and Shoon K. Kim. 175, 1164 (1968)
KINGSBURY, Paul I., Jr.
Defects in Rutile. I. Electron Paramagnetic Resonance of Interstitially Doped $n$-Type Rutile—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1091 (1968)
Defects in Rutile. II. Diffusion of Interstitial Ions—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1099 (1968)
Defects in Rutile. III. Optical and Electrical Properties of Impurities and Charge Carriers—O. W. Johnson, W. D. Ohlsen, and Paul I. Kingsbury, Jr. 175, 1102 (1968)
KINO, G. S.
Transport Properties of GaAs—J. G. Ruch and G. S. Kino. 174, 921 (1968)
KINSEY, B. B.
Neutron Cross-Section Measurements of $^{12}$C between 14 and 25 MeV—F. Boreli, B. B. Kinsey, and P. N. Shrivastava. 174, 1147 (1968)
Proton and Neutron Resonances in Nitrogen—F. Boreli, P. N. Shrivastava, B. B. Kinsey, and V. C. Mistry. 174, 1221 (1968)
KINSEY, R. R.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)
KIRK, Thomas B. W.
Scattering of High-Energy Positive and Negative Muons on Electrons—Thomas B. W. Kirk and Seth H. Neddermeyer. 171, 1412 (1968)
KIRKPATRICK, S.
Single-Site Approximations in the Electronic Theory of Simple Binary Alloys—B. Velický, S. Kirkpatrick, and H. Ehrenreich. 175, 747 (1968)
KIRSCH, Lawrence
Search for a Strange Boson of Mass Less than 670 MeV—Lawrence Kirsch. 175, 1733 (1968)
KISHORE, R.
Acoustic Attenuation in Solids—R. Kishore. 173, 856 (1968)
KISLIUK, P.
Optical Spectrum and Zeeman Effect of $CaF_2$:$Eu^{2+}$—P. Kisliuk, H. H. Tippins, C. A. Moore, and S. A. Pollack. 171, 336 (1968)

KISTNER, O. C.
Resonant Absorption in the Presence of Faraday Rotation—M. Blume and O. C. Kistner. 171, 417 (1968)
KITCHENS, T. A.
Phonon Spectrum of hcp $He^4$—V. J. Minkiewicz, T. A. Kitchens, F. P. Lipschultz, R. Nathans, and G. Shirane. 174, 267 (1968)
Magnetization Distribution in Magnetically Diluted Systems with Application to Iron-Palladium—T. A. Kitchens and W. L. Trousdale. 174, 606 (1968)
KLAUDER, L. T., Jr.
Mechanism for the Photoreflectance Effect—J. G. Gay and L. T. Klauder, Jr. 172, 811 (1968)
KLEIN, A. P.
New Calculation of the Magnetic Susceptibility for the Takano-Ogawa Theory of Kondo's Effect in Dilute Alloys—A. P. Klein. 172, 520 (1968)
KLEIN, Abraham
Concept of Ideal Collective Coordinate as the Foundation for a Phenomenological Theory of Nuclear Collective Motion: Basic Ideas and Relation to Other Phenomenological Methods—Abraham Klein, R. M. Dreizler, and Robert E. Johnson. 171, 1216 (1968)
Application of the Concept of Ideal Collective Coordinate to a Simple Microscopic Model—Abraham Klein and Robert E. Johnson. 171, 1224 (1968)
Self-Consistent Theory of Nuclear Spectra: Pairing-Force Model—Giu Do Dang, R. M. Dreizler, Abraham Klein, and Chi-Shiang Wu. 172, 1022 (1968)
KLEIN, Michael W.
Temperature-Dependent Internal Field Distribution and Magnetic Susceptibility of a Dilute Ising Spin System—Michael W. Klein. 173, 552 (1968)
KLEIN, S.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)
KLEINMAN, D. A.
Theory of Optical Parametric Noise—D. A. Kleinman. 174, 1027 (1968)
KLEINMAN, Leonard
Exchange and the Dielectric Screening Function—Leonard Kleinman. 172, 383 (1968)
KLEMA, E. D.
Nuclear Pairing Energy of Transition Nucleus $Pu^{240}$—J. R. Huizenga, A. N. Behkami, J. W. Meadows, Jr., and E. D. Klema. 174, 1539 (1968)
KLEMENS, P. G.
Phonon-Assisted Impurity Scattering in Gold Alloys—D. H. Damon, M. P. Mathur, and P. G. Klemens. 176, 876 (1968)
KLEMM, A.
Atomic Hyperfine Structure. I. Polarization Wave Functions for the Ground States of B, C, N, O, and F.—Henry F. Schaefer III, Richard A. Klemm, and Frank E. Harris. 176, 49 (1968)
KLEY, W.
Disappearance of a Vibrational Mode in the Ferroelectric Phase Transition of $KH_2PO_4$—Ch. Schenk, E. Wiener, B. Weckermann, and W. Kley. 172, 576 (1968)
KLIEWER, K. L.
Anomalous Skin Effect for Specular Electron Scattering and Optical Experiments at Non-Normal Angles of Incidence—K. L. Kliewer and Ronald Fuchs. 172, 607 (1968)
KLIGMAN, Ronald
Application of the Cluster-Variation Method to the Uniaxial Antiferromagnet $FeF_2$—Tomoyasu Tanaka, Louis Libelo, and Ronald Kligman. 171, 531 (1968)
KLINK, William H.
$\pi$-Particle Kinematics and a Generalized Partial-Wave Analysis—William H. Klink and Granville J. Smith II. 175, 2010 (1968)
KNASEL, T. M.
Incoherent-Scattering Function, Total Pair-Production Cross Section, and Pair-Production Length for Helium—T. M. Knasel. 171, 1643 (1968)
KNAUER, Robert C.
Direct Observation of Solid-State Diffusion Using the Mössbauer Effect—Robert C. Knauer and James G. Mullen. 174, 711 (1968)
KNIES, G.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)
KNYSTAUTAS, E. J.
Coincidence Measurements of Krypton-Krypton Collisions—M. P. McCaughey, E. J. Knystautas, and E. Everhart. 175, 14 (1968)
KOCH, H. R.
Nuclear Levels in $^{142}Pr$—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)
KOCH, J. F.
Surface Quantum States and Impedance Oscillations in a Weak Magnetic Field—Numerical Aspects—T. W. Nee, J. F. Koch, and R. E. Prange. 174, 758 (1968)
KOEHLER, J. S.
Stage-III Annealing in Gold after Electron Irradiation—C. Lee and J. S. Koehler. 176, 813 (1968)
KOEHLER, T. R.
Calculation of the Self-Consistent Phonon Spectrum of hcp $He^4$—N. S. Gillis, T. R. Koehler, and N. R. Werthamer. 175, 1110 (1968)
KOEHLER, W. C.
Magnetic Structure Properties of Alloys of Tb, Ho, and Er with Sc—H. R. Child and W. C. Koehler. 174, 562 (1968)
Note on the Scattering Cross Sections of the Isotopes of Dysprosium—H. R. Child, L. J. Raubenheimer, W. C. Koehler, and R. M. Moon. 174, 1553 (1968)
Magnetic Structures of $Er_2O_3$ and $Yb_2O_3$—R. M. Moon, W. C. Koehler, H. R. Child, and L. J. Raubenheimer. 176, 722 (1968)
KOENIG, S. H.
Tilt of the Electron Fermi Surface in Bi—R. D. Brown, R. L. Hartman, and S. H. Koenig. 172, 598 (1968)
KOHL, R. H.
Theory for the Measurement of the Earth's Velocity through the 3°K Cosmic Radiation—C. V. Heer and R. H. Kohl. 174, 1611 (1968)
KOHLER, D.
Magnetic Dipole Transitions and Isospin in $Be^8$—P. Paul, D. Kohler, and K. A. Snover. 173, 919 (1968)
KOK, L. P.
Analysis of the ΛΛ Hypernucleus $_{\Lambda\Lambda}C^{14}$—S. Ali, L. P. Kok, and M. E. Grypeos. 171, 1203 (1968)
KOLATA, J. J.
Energy-Loss Straggling of Protons in Silicon—J. J. Kolata, T. M. Amos, and Hans Bichsel. 176, 484 (1968)
KOLBENSTVEDT, Hans
Polarization Effects in Induced Emission of Bremsstrahlung—Hans Kolbenstvedt and Haakon A. Olsen. 175, 11 (1968)

KOLOPUS, James L.
ESR Studies of Radiation-Damage Centers in Barium Sulfide—James L. Kolopus and Gerald J. Lapeyre. 176, 1025 (1968)
KOLOUCH, R. J.
Orientation Dependence of Ultrasonic Attenuation in Copper—E. Y. Wang, R. J. Kolouch, and K. A. McCarthy. 175, 723 (1968)
KOMY, S. R.
Lorentz-Pole Model and Polarization in High-Energy Charge-Exchange Pion-Nucleon Scattering—N. G. Antoniou, S. R. Komy, C. D. Palev, and M. Samiullah. 175, 1757 (1968)
KONECNY, E.
Fission Energetics and Neutron Emission in 13-MeV Proton-Induced Fission of $^{226}$Ra—E. Konecny and H. W. Schmitt. 172, 1213 (1968)
Asymmetry, Anisotropy, and Excitation Function for the Proton-Induced Fission of $^{226}$Ra—E. Konecny and H. W. Schmitt. 172, 1226 (1968)
KONINGSTEIN, J. A.
Selection Rules for an Electronic Raman Effect in a Situation where the Appropriate Point Group is a Double Group—J. A. Koningstein. 174, 477 (1968)
KOO, E. Ley
Calculation of the Magnetic Moment of Atomic Fluorine—V. Beltrán-López, E. Ley Koo, N. Segovia, and E. Blaisten. 172, 44 (1968)
KOOZEKANANI, S. H.
Formation of Ionized Excited States Through the Loss of the Metastable Electron in Noble-Gas Atoms—S. H. Koozekanani. 176, 160 (1968)
KORRINGA, J.
Unitary Theory of Dynamic Polarization of Nuclear Spins in Liquids and Solids—P. Papon, J. L. Motchane, and J. Korringa. 175, 641 (1968)
KOSICKI, B. B.
$\Delta_1$ Conduction-Band Minimum of Ge from High-Pressure Studies on $p$-$n$ Junctions—A. Jayaraman, B. B. Kosicki, and J. C. Irvin. 171, 836 (1968)
Conduction-Band Structure of GaSb from Pressure Experiments to 50 kbar—B. B. Kosicki, A. Jayaraman, and William Paul. 172, 764 (1968)
KOSTOFF, M. R.
Polarization in $^{12}$C$(\vec{p},p)^{12}$C—G. E. Terrell, M. F. Jahns, M. R. Kostoff, and E. M. Bernstein. 173, 931 (1968)
KOTTLER, H.
Statistical Model for High-Energy Reactions—L. L. Foldy, H. Kottler, D. R. Speiser, and J. Weyers. 173, 1517 (1968)
KOTTWITZ, D. A.
Intensity of Forbidden Neutron Reflections Simulated by Multiple Bragg Reflection—D. A. Kottwitz. 175, 1056 (1968)
KOUSTROUN, Vaclav O.
Total Internal Conversion Coefficient of the 23.9-keV Ground-State Transition in $^{119m}$Sn—Vaclav O. Koustroun and Bernd Crasemann. 174, 1535 (1968)
KOWALSKI, L.
Study of the Particles Emitted from $Br^{75}$ Compound Nuclei Formed in Two Ways: $C^{12} + Cu^{63}$ and $O^{16} + Co^{59}$—J. M. D'Auria, M. J. Fluss, G. Herzog, L. Kowalski, J. M. Miller, and R. C. Reedy. 174, 1409 (1968)
KOZUB, R. L.
$(p,d)$ Reaction on $N = Z$ Nuclei in the $2s$-$1d$ Shell—R. L. Kozub. 172, 1078 (1968)
KRAEMER, R. W.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)
KRAICHNAN, Robert H.
Convergents to Infinite Series in Turbulence Theory—Robert H. Kraichnan. 174, 240 (1968)
KRASS, Allan S.
Radiative Correction to Pion Photoproduction—Charles Picciotto and Allan S. Krass. 174, 2109 (1968)
KRAUSE, Daniel, Jr.
Polarization of Light from Collisions of a Proton Beam with Helium Atoms—Daniel Krause, Jr., and Edward A. Soltysik. 175, 142 (1968)
KRAYBILL, H. I.
Pion Production and Elastic Scattering in Antiproton-Proton Collisions at 6.94 BeV/$c$—T. Ferbel, J. A. Johnson, H. I. Kraybill, J. Sandweiss, and H. D. Taft. 173, 1307 (1968)
KREISLER, Michael N.
Quest for Faster-Than-Light Particles—Torsten Alväger and Michael N. Kreisler. 171, 1357 (1968)
KRÉN, E.
Magnetic Structures and Exchange Interactions in the Mn–Pt System—E. Krén, G. Kádár, L. Pál, J. Sólyom, P. Szabó, and T. Tarnóczi. 171, 574 (1968)
KREPS, R. E.
Dipole $\rho$ Meson, Nucleon Form Factors, and Charge-Exchange Scattering—R. E. Kreps and J. W. Moffat. 175, 1942 (1968)
Nucleon and Pion Form Factors and the Dipole $\rho$ Meson—R. E. Kreps and J. W. Moffat. 175, 1945 (1968)
KRISS, M.
Superfluid Helmholtz Resonators—M. Kriss and I. Rudnick. 174, 326 (1968)
KROES, Roger L.
Additive Coloration of Alkaline-Earth Chalcogenides—Eugene B. Hensley, Wirt C. Ward, Bruce P. Johnson, and Roger L. Kroes. 175, 1227 (1968)
KROGH, Christine
Lunar Laser Ranging and the Brans-Dicke Theory—Christine Krogh and Ralph Baierlein. 175, 1576 (1968)
KRUEGER, David A.
Finite Geometries and Ideal Bose Gases—David A. Krueger. 172, 211 (1968)
KRUMHANSL, J. A.
Effect of Force-Constant Changes on the Incoherent Neutron Scattering from Cubic Crystals with Point Defects—Katja Lakatos and J. A. Krumhansl. 175, 841 (1968)
KRUSE, T. H.
Elastic and Inelastic Proton Scattering from Even Isotopes of Cd, Sn, and Te—W. Makofske, W. Savin, H. Ogata, and T. H. Kruse. 174, 1429 (1968)
KRUSE, U. E.
Reactions $\bar{K}^- p \to \Sigma^{\pm} \pi^{\mp}$ at 4.07 and 5.47 GeV/$c$—J. S. Loos, U. E. Kruse, and E. L. Goldwasser. 173, 1330 (1968)
KUBIS, Joseph J.
Reaction Amplitudes for Pseudoscalar Mesons on Spin-$\frac{1}{2}$ Fermions in Fourth-Order Perturbation Theory—Joseph J. Kubis and John L. Gammel. 172, 1664 (1968)
KUCHNIR, F. T.
Small-Angle Scattering of Neutrons by Heavy Nuclei—F. T. Kuchnir, A. J. Elwyn, J. E. Monahan, A. Langsdorf, Jr., and F. P. Mooring. 176, 1405 (1968)
KUKOLICH, Stephen G.
Hyperfine Structure of $N^{15}H_3$—Stephen G. Kukolich. 172, 59 (1968)

KULL, L. A.
Measurements of the $^{63}Cu(\gamma,n)$ and $(\gamma,2n)$ Cross Sections—R. E. Sund, M. P. Baker, L. A. Kull, and R. B. Walton. 176, 1366 (1968)

KUMAR, Arvind
"Non-Abelian Compton Effect" on Spin-One Targets—Arvind Kumar. 175, 2148 (1968)

KUMAR, N.
Possibility of Photoinduced Superconductivity—N. Kumar and K. P. Sinha. 174, 482 (1968)

KUMAR, Santosh
Theoretical Study on the Anisotropy of the Spin-Lattice Relaxation for Paramagnetic Ions by MgO Crystal—Santosh Kumar, T. Ray, and D. K. Ray. 176, 489 (1968)

KUNZ, A. Barry
Application of the Orthogonalized-Plane-Wave Method to Lithium Chloride, Sodium Chloride, and Potassium Chloride—A. Barry Kunz. 175, 1147 (1968)

KUO, P. K.
Analyticity and Broken $SL(2, C)$ Symmetry for Regge Families—P. K. Kuo and James F. Walker. 175, 1794 (1968)
Analyticity and Broken $O(4)$ Symmetry—J. B. Bronzan, C. Edward Jones, and P. K. Kuo. 175, 2200 (1968)

KUPPERMANN, Aron
Rearrangement Collisions: Effect of Core Terms, Nonorthogonality, and Conservation of Particle Flux on Approximate Theories—Donald G. Truhlar, David C. Cartwright, and Aron Kuppermann. 175, 113 (1968)

KURIYAN, Jacob G.
Threshold Electropion Production from Current Algebra and Partially Conserved Axial-Vector Current—A. M. Gleeson, M. G. Gundzik, and Jacob G. Kuriyan. 173, 1708 (1968)

KURTZ, S. K.
Atomic Displacement Relationship to Curie Temperature and Spontaneous Polarization in Displacive Ferroelectrics—S. C. Abrahams, S. K. Kurtz, and P. B. Jamieson. 172, 551 (1968)

KUSHIDA, Toshinoto
Fermi Surface of Potassium as Measured by Helicon Doppler-Shifted Cyclotron Resonance—P. A. Penz and Toshinoto Kushida. 176, 804 (1968)

KUTZELNIGG, Werner
Correlation Coefficients for Electronic Wave Functions—Werner Kutzelnigg, Giuseppe Del Re, and Gaston Berthier. 172, 49 (1968)

KUZNIETZ, M.
Magnetic Properties of Uranium Compounds with Elements of the *VA* and *VIA* Groups. I. Compounds of *UX* Type—J. Grunzweig-Genossar, M. Kuznietz, and F. Friedman. 173, 562 (1968)

KWO, W. T.
Non-Closed-Shell Linear Chain: The $H_{2n}$ System—W. T. Kwo. 171, 484 (1968)

KWOK, P. C.
Phonons in Time-Dependent Hartree Approximation with Application to Order-Disorder Ferroelectrics—P. B. Miller and P. C. Kwok. 175, 1062 (1968)
Theory of Heat-Pulse Propagation in a Phonon Gas—P. C. Kwok. 175, 1208 (1968)

KYKER, G. C., Jr.
High-Resolution Study of Isobaric Analog Resonances in $^{23}Na$—G. A. Keyworth, P. Wilhjelm, G. C. Kyker, Jr., H. W. Newson, and E. G. Bilpuch. 176, 1302 (1968)

KYLE, H. Lee
Electron-Impact Ionization of H (2*s*) and H (2*p*)—H. Lee Kyle and K. Omidvar. 176, 164 (1968)

KYRIAKOPOULOS, E.
Dynamical Groups and the Bethe-Salpeter Equation—E. Kyriakopoulos. 174, 1846 (1968)

LA, S. Y.
Pressure Derivatives of Second-Order Elastic Constants of MgO—S. Y. La and G. R. Barsch. 172, 957 (1968)

LABBÉ, J.
Relation between Superconductivity and Lattice Instability in the $\beta$-W Compounds—J. Labbé. 172, 451 (1968)

LADENBAUER-BELLIS, Inge-Maria
Decay Studies of Iodine-118 and -120—Inge-Maria Ladenbauer-Bellis and H. Bakhru. 175, 1507 (1968)

LAGALLY, Max G.
Multiphonon Scattering of Low-Energy Electrons—Robert F. Barnes, Max G. Lagally, and Maurice B. Webb. 171, 627 (1968)

LAKATOS, Katja
Effect of Force-Constant Changes on the Incoherent Neutron Scattering from Cubic Crystals with Point Defects—Katja Lakatos and J. A. Krumhansl. 175, 841 (1968)

LAM, W. S.
Unitarity Corrections to Pole Dominance in Spectral-Function Sum Rules—W. S. Lam and K. Raman. 173, 1497 (1968)

LAMBRAKOS, K. F.
Determination of the Pion Form Factor by Electroproduction of Pions—K. F. Lambrakos and T. A. Griffy. 175, 1948 (1968)

LAMPE, Martin
Transport Theory of a Partially Degenerate Plasma—Martin Lampe. 174, 276 (1968)

LAND, R. H.
Electron Correlations at Metallic Densities—K. S. Singwi, M. P. Tosi, R. H. Land, and A. Sjölander. 176, 589 (1968)

LANDMAN, Donald A.
Lifetimes and Alignment Depolarization Cross Sections of the $(3p^5\,4p)\ ^3D_3$ and $^1D_2{}^o$ Levels in Argon and the $(1s\,2p)\ ^3P$ Term in Helium—Donald A. Landman. 173, 33 (1968)

LANDOVITZ, Leon F.
Subsidiary Condition in Quantum Electrodynamics—Kurt Haller and Leon F. Landovitz. 171, 1749 (1968)

LANDSBERG, P. T.
Concentration Quenching of Luminescence by Donors or Acceptors in Gallium Phosphide and the Impurity-Band Auger Model—J. C. Tsang, P. J. Dean, and P. T. Landsberg. 173, 814 (1968)

LANE, Neal F.
Polarization Potential in Low-Energy Electron-$H_2$ Scattering—Neal F. Lane and Ronald J. W. Henry. 173, 183 (1968)
Diffusion of $He(2^3S_1)$ in Helium Gas; $2\ ^3S_1 - 1\ ^1S_0$ Interaction Potentials at Long Range—W. A. Fitzsimmons, N. F. Lane, and G. K. Walters. 174, 193 (1968)

LANGE, James N.
Hypersonic Attenuation in Rutile—James N. Lange. 176, 1030 (1968)

LANGHANS, L.
Resonance Scattering of Slow Electrons from $H_2$ and CO Angular Distributions—H. Ehrhardt, L. Langhans, F. Linder, and H. S. Taylor. 173, 222 (1968)

LANGLEY, R. A.
Measurement of High-Energy Charge-Transfer Cross Sections for Incident Protons and Atomic Hydrogen in Various Gases—L. H. Toburen, M. Y. Nakai, and R. A. Langley. 171, 114 (1968)

LANGSDORF, A., Jr.
Small-Angle Scattering of Neutrons by Heavy Nuclei—F. T. Kuchnir, A. J. Elwyn, J. E. Monahan, A. Langsdorf, Jr., and F. P. Mooring. 176, 1405 (1968)

LANNUTTI, J. E.
$\pi^- p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)

LAPEYRE, Gerald J.
ESR Studies of Radiation-Damage Centers in Barium Sulfide—James L. Kolopus and Gerald J. Lapeyre. 176, 1025 (1968)

LARAMORE, George
Anomalous Electrical Conductivity above the Superconducting Transition—Leo P. Kadanoff and George Laramore. 175, 579 (1968)

LARSEN, David M.
Upper and Lower Bounds for the Intermediate-Coupling Polaron Ground-State Energy—David M. Larsen. 172, 967 (1968)

Intermediate-Coupling Polaron Effective Mass—David M. Larsen. 174, 1046 (1968)

LASHER, Gordon
Coherent Phonon States and Long-Range Order in Two-Dimensional Bose Systems—Gordon Lasher. 172, 224 (1968)

LASSILA, K. E.
Polarization in $\pi^- p \to \eta n$, the Double-Pole $A_2$, and a Possible Pion Conspirator—D. M. Austin, J. V. Beaupre, and K. E. Lassila. 173, 1573 (1968)

LAUGHLIN, Robert
Off-Energy-Shell $t$-Matrix Elements for Local Potentials Containing Hard Cores—Robert Laughlin and Bruce L. Scott. 171, 1196 (1968)

LAURENS, G.
$\pi^- p \to \pi^- \pi^0 p$ Reaction at 2.77 GeV/$c$ for Low Momentum Transfers to the Proton—J. P. Baton and G. Laurens. 176, 1574 (1968)

LAUTRUP, B. E.
Calculation of the Sixth-Order Contribution from the Fourth-Order Vacuum Polarization to the Difference of the Anomalous Magnetic Moments of Muon and Electron—B. E. Lautrup and E. de Rafael. 174, 1835 (1968)

LAWAETZ, P.
Low-Field Mobility and Galvanomagnetic Properties of Holes in Germanium with Phonon Scattering—P. Lawaetz. 174, 867 (1968)

LAWLESS, W. N.
180° Domain-Wall Energies in $BaTiO_3$—W. N. Lawless. 175, 619 (1968)

LAWRENCE, F. O.
Beta Decay of $^{144}$Ce—D. C. Hoffman, F. O. Lawrence, and W. R. Daniels. 172, 1239 (1968)

LAWRENCE, George M.
Radiative Lifetimes in the Resonance Series of Ar I—George M. Lawrence. 175, 40 (1968)

LAWRENCE, W. E.
Fermi Surface and Electronic Structure of Indium—N. W. Ashcroft and W. E. Lawrence. 175, 938 (1968)

LAWSON, A. W.
Magnetocrystalline Anisotropy of Europium Selenide—R. F. Brown, A. W. Lawson, and Glen E. Everett. 172, 559 (1968)

LAX, Benjamin
Theory of Multiphoton Magnetoabsorption in Semiconductors—Margaret H. Weiler, M. Reine, and Benjamin Lax. 171, 949 (1968)

LAX, Melvin
Quantum Noise. XI. Multitime Correspondence between Quantum and Classical Stochastic Processes—Melvin Lax. 172, 350 (1968)

Quantum Noise. XIII. Six-Classical-Variable Description of Quantum Laser Fluctuations—Melvin Lax and Horace Yuen. 172, 362 (1968)

LEACOCK, R. A.
$K^- p$ Elastic Scattering at 4.6 GeV/$c$—L. S. Schroeder, R. A. Leacock, R. L. Wagstaff, and W. J. Kernan. 176, 1648 (1968)

LEATH, Paul L.
Self-Consistent-Field Approximations in Disordered Alloys—P. L. Leath. 171, 725 (1968)

Displacement Correlations and Frequency Spectra for Mass-Disordered Lattices. II—Paul L. Leath and Bernard Goodman. 175, 963 (1968)

LEBOWITZ, J. L.
Time Evolution of the Total Distribution Function of a One-Dimensional System of Hard Rods—J. L. Lebowitz, J. K. Percus, and J. Sykes. 171, 224 (1968)

LEE, C.
Stage-III Annealing in Gold after Electron Irradiation—C. Lee and J. S. Koehler. 176, 813 (1968)

LEE, C. H.
Optical Second-Harmonic Generation in Reflection from Media with Inversion Symmetry—N. Bloembergen, R. K. Chang, S. S. Jha, and C. H. Lee. 174, 813 (1968)

LEE, G. B.
Neutron Diffraction by Liquid Zinc—B. A. Dasannacharya, Q. O. Navarro, H. Ibarra, S. Chatraphorn, and G. B. Lee. 173, 241 (1968)

LEE, Huan
Regge-Pole Formalism for Pionic Disintegration of Deuteron—Huan Lee. 174, 2130 (1968)

LEE, Kenneth
$S^{33}$ Nuclear Magnetic Resonance in Paramagnetic $\alpha$-MnS—Kenneth Lee. 172, 284 (1968)

LEE, P. M.
Band Structure and Electronic Properties of Silver—P. E. Lewis and P. M. Lee. 175, 795 (1968)

LEE, Sang Soo
Nuclear Radio-Frequency Spectra of a Series of Tetrahedral Molecules—Irving Ozier, Lawrence M. Crapo, and Sang Soo Lee. 172, 63 (1968)

LEE, T. D.
Intermediate Bosons and the Electromagnetic Field—T. D. Lee. 171, 1731 (1968)

Erratum: Application of $\xi$-Limiting Process to Intermediate Bosons—T. D. Lee. [128, 899 (1962)] 173, 1806 (1968)

LEE, Y. C.
Convergence of the Two-Component Plasma Correlation Function—Y. C. Lee, D. L. Lin, and Ta-You Wu. 172, 145 (1968)

LEGVOLD, Sam
Thermal Conductivities and Lorenz Functions of Dy, Er, and Lu Single Crystals—D. W. Boys and S. Legvold. 174, 377 (1968)

Transport Properties of Thulium Single Crystals—L. Roger Edwards and Sam Legvold. 176, 753 (1968)

LEHMAN, G. W.
Mass Dependence of the Angular Distribution of Charged-Particle Emission from Crystals: Transition to the Classical Limit—R. E. De Wames, W. F. Hall, and G. W. Lehman. 174, 392 (1968)

LEHMAN, Richard L.
Neutron Groups in the Spectrum of a $PuF_4$ Source—Richard L. Lehman. 171, 1311 (1968)

LEHMANN, Gerhard
Photoconductivity in Colored Potassium Chloride—Frances H. Chapple, Gerhard Lehmann, and Allen B. Scott. 174, 1012 (1968)

LEHMANN, W.
Piezoresistance and Piezo-Hall Effects in $n$-ZnSe—A. Sagar, M. Pollak, and W. Lehmann. 174, 859 (1968)
LEIBOWITZ, J. R.
Ultrasonic Investigation of the Isolated-Vortex State near $H_{c1}$ in Vanadium—A. C. E. Sinclair and J. R. Leibowitz. 175, 596 (1968)
LEITE, R. C. C.
Donor-Acceptor Pair Recombination Involving the First Excited State of a Donor in GaAs—Jagdeep Shah, R. C. C. Leite, and J. P. Gordon. 176, 938 (1968)
LEMMER, R. H.
Use of a Truncated Hilbert Space in Nuclear Reaction Calculations—Jörg Hüfner and R. H. Lemmer. 175, 1394 (1968)
LEONARD, A.
Exact Inversion of the Fugacity-Density Relation for Ideal Quantum Gases—A. Leonard. 175, 221 (1968)
LEONARD, R. F.
Core Excitations in $^{107}$Ag, $^{109}$Ag, $^{113}$In, $^{115}$In, $^{121}$Sb, and $^{123}$Sb Resulting from Inelastic Scattering of 42-MeV Alpha Particles—W. M. Stewart, N. Baron, and R. F. Leonard. 171, 1316 (1968)
LEONARDI, R.
$T$-Violation Effects and Final-State Interactions—G. Karpman, R. Leonardi, and F. Strocchi. 174, 1957 (1968)
LEPPELMEIER, G. W.
Measurement of the Nuclear Spin Diffusion Coefficient in $CaF_2$—G. W. Leppelmeier and J. Jeener. 175, 498 (1968)
LESK, Arthur M.
Use of the Hartree-Fock Approximation in Computing Electron Affinities—Arthur M. Lesk. 171, 7 (1968)
LEVIN, David N.
Off-Mass-Shell Corrections to Current-Algebra Calculation of $\pi N$ $S$-Wave Scattering Lengths—David N. Levin. 174, 1759 (1968)
LEVINE, B. F.
Magnetic Properties of $Ga_{2-x}Fe_xO_3$—B. F. Levine, C. H. Nowlin, and R. V. Jones. 174, 571 (1968)
LEVINE, Howard B.
Erratum: Quantum Theory of Collision-Induced Absorption in Rare-Gas Mixtures—Howard B. Levine. [160, 159 (1967)]
LEVINE, Judah
Measurement of the Electric Dipole Polarizabilities of Metastable Mercury—Judah Levine, Robert J. Celotta, and Benjamin Bederson. 171, 31 (1968)
LEVINE, Jules D.
Ionic, Covalent, and Metallic Surface States of a One-Dimensional Mathieu Potential with Arbitrary Termination—Jules D. Levine. 171, 701 (1968)
Ionic Surface States from a Band-Edge Method—Jules D. Levine and S. G. Davison. 174, 911 (1968)
LEVINE, M.
Further Investigation of Local Moments in Metals—M. Levine and H. Suhl. 171, 567 (1968)
LEVINSON, C. A.
Universal Coupling of the $\omega$ Meson and Regge Residues—M. K. Banerjee and C. A. Levinson. 176, 2140 (1968)
LEVINSON, Lionel M.
Spin Relaxation in Mössbauer Spectra of Magnetically Ordered Systems—Lionel M. Levinson and Marshall Luban. 172, 268 (1968)
LEVINSTEIN, H. J.
Magnetic Properties of the Planar Antiferromagnet $Rb_2FeF_4$—G. K. Wertheim, H. J. Guggenheim, H. J. Levinstein, D. N. E. Buchanan, and R. C. Sherwood. 173, 614 (1968)
LEWIS, H. R., Jr.
Motion of a Time-Dependent Harmonic Oscillator, and of a Charged Particle in a Class of Time-Dependent, Axially Symmetric Electromagnetic Fields—H. R. Lewis, Jr. 172, 1313 (1968)
LEWIS, P. E.
Band Structure and Electronic Properties of Silver—P. E. Lewis and P. M. Lee. 175, 795 (1968)
LI, T. Y.
Analysis of the $C^{12}(p,\alpha)B^9$ Reaction at 44.5 MeV—T. Y. Li and B. Hird. 174, 1130 (1968)
LIBBY, L. Marshall
Pion-Nucleon Elastic Scattering above 1 GeV—E. Rost and L. Marshall Libby. 175, 1869 (1968)
LIBELO, Louis
Application of the Cluster-Variation Method to the Uniaxial Antiferromagnet $FeF_2$—Tomoyasu Tanaka, Louis Libelo, and Ronald Kligman. 171, 531 (1968)
LIBERMAN, David A.
Exchange Potential for Electrons in Atoms and Solids—David A. Liberman. 171, 1 (1968)
LICHTENBERG, D. B.
Electromagnetic Properties of Baryons in a Quark-Diquark Model with Broken $SU(6)$—James Carroll, D. B. Lichtenberg, and J. Franklin. 174, 1681 (1968)
LIEB, K. P.
Isobaric-Analog Study of $^{90}$Zr—K. P. Lieb, James J. Kent, and C. Fred Moore. 175, 1482 (1968)
LIEBER, Michael
$O(4)$ Symmetry of the Hydrogen Atom and the Lamb Shift—Michael Lieber. 174, 2037 (1968)
LIFSITZ, J. R.
Anti-Stokes Generation in Trapped Filaments of Light—C. A. Sacchi, C. H. Townes, and J. R. Lifsitz. 174, 439 (1968)
LIGHTOWLERS, E. C.
Photothermal Ionization and Photon-Induced Tunneling in the Acceptor Photoconductivity Spectrum of Semiconducting Diamond—A. T. Collins and E. C. Lightowlers. 171, 843 (1968)
Electric-Field Modulation of Luminescence-Excitation in Natural Diamond in the Spectral Energy Range 5.0–6.0 eV—P. Denham and E. C. Lightowlers. 174, 800 (1968)
LILLEY, J. S.
Two-Neutron-Hole Configurations in $Pb^{206}$ from Isobaric Analog Measurements—Patrick Richard, Nelson Stein, C. D. Kavaloski, and J. S. Lilley. 171, 1308 (1968)
LIM, C. P.
Measurements of the Stark Broadening of Two Neutral Helium Lines in a Plasma—J. R. Greig, C. P. Lim, G. A. Moo-Young, G. Palumbo, and Hans R. Griem. 172, 148 (1968)
LIN, D. L.
Convergence of the Two-Component Plasma Correlation Function—Y. C. Lee, D. L. Lin, and Ta-You Wu. 172, 145 (1968)
LIN, H. E.
Superconvergence Relations and Possible New Resonances in Pion-Baryon Scattering—D. Kiang, W. C. Lin, R. Sugano, H. E. Lin, and Y. Nogami. 176, 2159 (1968)
LIN, W. C.
Superconvergence Relations and Possible New Resonances in Pion-Baryon Scattering—D. Kiang, W. C. Lin, R. Sugano, H. E. Lin, and Y. Nogami. 176, 2159 (1968)
LINDBLOM, P.
Physical Region on the Plane of Two Invariant Momentum Transfers for a Reaction with Three Particles in the Final State—K. Kajantie and P. Lindblom. 175, 2203 (1968)

LINDER, F.
Resonance Scattering of Slow Electrons from $H_2$ and CO Angular Distributions—H. Ehrhardt, L. Langhans, F. Linder, and H. S. Taylor. 173, 222 (1968)
LINDGREN, Ingvar
Relativistic Calculations of Electron Binding Energies by a Modified Hartree-Fock-Slater Method—Arne Rosén and Ingvar Lindgren. 176, 114 (1968)
LING, S. C.
Reaction $T(^3He,\gamma)^6Li$ in the Energy Range 0.5-11 MeV—S. L. Blatt, A. M. Young, S. C. Ling, K. J. Moon, and C. D. Porterfield. 176, 1147 (1968)
LIOSSATOS, P. S.
Compositeness Conditions in Bronzan's Version of the Lee Model—P. S. Liossatos. 172, 1554 (1968)
LIPINSKI, H. M.
$O(4)$ Symmetry and the Regge Trajectory of the Pion—W. R. Frazer, H. M. Lipinski, and D. R. Snider. 174, 1932 (1968)
Connection between the Toller Quantum Number $M$ and the Small-$t$ Behavior of the Asymptotic $S$-Channel Helicity Amplitudes—John F. Gunion and H. M. Lipinski. 176, 2045 (1968)
$O(4)$ Expansion of Off-Shell Scattering Amplitudes—W. R. Frazer, F. R. Halpern, H. M. Lipinski, and D. R. Snider. 176, 2047 (1968)
$O(4)$ Symmetry, $NN$ Scattering, and the Regge Trajectory of the Pion—H. M. Lipinski and D. R. Snider. 176, 2054 (1968)
LIPKIN, Harry J.
Isospin and $U$-Spin Dependence of Hadron-Nucleon Total Cross Sections—Harry J. Lipkin. 174, 2151 (1968)
Interference, Mixing, and Angular Correlations in Decays of Boson Resonances—Harry J. Lipkin. 176, 1709 (1968)
$CP$ Violation and Coherent Decays of Kaon Pairs—Harry J. Lipkin. 176, 1715 (1968)
LIPSCHULTZ, F. P.
Phonon Spectrum of hcp $He^4$—V. J. Minkiewicz, T. A. Kitchens, F. P. Lipschultz, R. Nathans, and G. Shirane. 174, 267 (1968)
LIPSICAS, M.
Nuclear Spin-Lattice Relaxation in Very Dilute Solutions of Orthohydrogen in Parahydrogen—C. E. Miller and M. Lipsicas. 176, 273 (1968)
LIPWORTH, E.
Electric Dipole Moments of Alkali Atoms. A Limit to the Electric Dipole Moment of the Free Electron—J. P. Carrico, E. Lipworth, P. G. H. Sandars, T. S. Stein, and M. C. Weisskopf. 174, 125 (1968)
LITTON, C. W.
Excited States of Bound Exciton Complexes in CdS—D. C. Reynolds, C. W. Litton, and T. C. Collins. 174, 845 (1968)
LIU, L.
Dielectric Singularity of α-Sn—L. Liu and David Brust. 173, 777 (1968)
LIU, Yu-Chien
Superconvergent Dispersion Relation and Low-Energy Kaon-Proton Interaction—Yu-Chien Liu. 172, 1564 (1968)
LOBO, R.
Helium Drag in the Theory of Impurity Mobility in Liquid Helium—M. Bailyn and R. Lobo. 176, 222 (1968)
LOCARD, P. J.
$^6Li(p,p)^6Li$(3.56 MeV) Reaction from $E_p$=24.3 to 46.4 MeV and the Effective Interaction—S. M. Austin, P. J. Locard, W. Benenson, and G. M. Crawley. 176, 1227 (1968)
LOCK, G. A.
$^{31}P(d,\alpha)^{29}Si$ Reaction from 7.3 to 12.0 MeV—G. A. Lock, J. R. Curry, P. J. Riley, and C. G. Shugart. 176, 1293 (1968)
LOEFFLER, F. J.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)
LOGUE, L. J.
Static Coulomb Corrections to the Point-Nucleus Fermi Function in Nuclear Beta Decay—L. J. Logue and B. Chern. 175, 1367 (1968)
LOH, Eugene
$4f^n \rightarrow 4f^{n-1}5d$ Spectra of Rare-Earth Ions in Crystals—Eugene Loh. 175, 533 (1968)
LOLY, P. D.
Estimate of Damping of Short-Wave Magnons for a Heisenberg Ferromagnet below $T_C$—P. D. Loly and S. Doniach. 173, 603 (1968)
LOMBARD, R. J.
Statistical Theory of Nuclei—K. A. Brueckner, J. R. Buchler, S. Jorna, and R. J. Lombard. 171, 1188 (1968)
LONE, M. A.
$Au^{197}(n,\gamma)Au^{198}$ Reaction Mechanism—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 173, 1170 (1968)
Resonant and Nonresonant Capture of Slow Neutrons in $Tm^{169}(n,\gamma)Tm^{170}$—M. A. Lone, R. E. Chrien, O. A. Wasson, M. Beer, M. R. Bhat, and H. R. Muether. 174, 1512 (1968)
Direct Neutron Capture in $Co^{59}(n,\gamma)Co^{60}$—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 176, 1314 (1968)
LONG, Donald
Calculation of Ionized-Impurity Scattering Mobility of Electrons in $Hg_{1-x}Cd_xTe$—Donald Long. 176, 923 (1968)
LONGWORTH, G.
Temperature Dependence of the $^{57}Fe$ hfs in the Ordered Alloys $FePd_3$ and FePd near the Curie Temperature—G. Longworth. 172, 572 (1968)
LOOMIS, David N.
Exact Classical Nonequilibrium Statistical-Mechanical Analysis of the Finite Ideal Gas—Arthur Hobson and David N. Loomis. 173, 285 (1968)
LOOS, J. S.
Reactions $K^- p \rightarrow \Sigma^{\pm}\pi^{\mp}$ at 4.07 and 5.47 GeV/$c$—J. S. Loos, U. E. Kruse, and E. L. Goldwasser. 173, 1330 (1968)
LOPEZ, A. A.
Electron-Hole Recombination in Bismuth—A. A. Lopez. 175, 823 (1968)
LORENZ, M. R.
Band Gap of Gallium Phosphide from 0 to 900°K and Light Emission from Diodes at High Temperatures—M. R. Lorenz, G. D. Pettit, and R. C. Taylor. 171, 876 (1968)
LORI, J.
Characteristics of Neutron Damage in Silicon—L. J. Cheng and J. Lori. 171, 856 (1968)
LOSEE, D. L.
Equilibrium Vacancy Concentration Measurements on Solid Krypton—D. L. Losee and R. O. Simmons. 172, 934 (1968)
Thermal-Expansion Measurements and Thermodynamics of Solid Krypton—D. L. Losee and R. O. Simmons. 172, 944 (1968)
Isotope Effects in the Lattice Constant and Thermal Expansion of $^{20}Ne$ and $^{22}Ne$ Single Crystals—D. N. Batchelder, D. L. Losee, and R. O. Simmons. 173, 873 (1968)
LOUAT, N.
Electronic Component of Dislocation Drag in Metals—G. P. Huffman and N. Louat. 176, 773 (1968)

LOUCKS, T. L.
Positron Annihilation in Yttrium and Zirconium—R. P. Gupta and T. L. Loucks. 176, 848 (1968)
LOVE, John C.
Coulomb-Recoil-Implantation Mössbauer Experiments with $^{73}$Ge—Gordon Czjzek, J. L. C. Ford, Jr., John C. Love, Felix E. Obenshain, and Horst H. F. Wegener. 174, 331 (1968)
LOVE, W. G.
Scattering of 24.5-MeV Protons from $^{89}$Y—W. Benenson, S. M. Austin, R. A. Paddock, and W. G. Love. 176, 1268 (1968)
LOVELAND, W.
Structure of the Fission Transition Nucleus $U^{238}$—A. N. Behkami, J. H. Roberts, W. Loveland, and J. R. Huizenga. 171, 1267 (1968)
LOW, F. E.
Photon Scattering from Bound Atomic Systems at Very High Energy—M. L. Goldberger and F. E. Low. 176, 1778 (1968)
LOWE, J.
Gamma-Ray Decay of the 6.92-, 7.12-, 8.88-, and 13.10-MeV States in $O^{16}$—D. H. Wilkinson, D. E. Alburger, and J. Lowe. 173, 995 (1968)
LOWELL, J.
Effect of Temperature and of Substitutional Mo on the Magnetic Behavior of Superconducting Nb—R. A. French and J. Lowell. 173, 504 (1968)
LOWE-PARISEAU, Marian
Zeeman Study of the Jahn-Teller Effect in the $^3T_{1g}$ State of $Al_2O_3:V^{3+}$—P. J. Stephens and Marian Lowe-Pariseau. 171, 322 (1968)
LOYD, D. H.
Charge-Exchange Collisions Between Helium Ions and Cesium Vapor in the Energy Range 1.5–25 keV—A. S. Schlachter, D. H. Loyd, P. J. Bjorkholm, L. W. Anderson, and W. Haeberli. 174, 201 (1968)
LUBAN, Marshall
Spin Relaxation in Mössbauer Spectra of Magnetically Ordered Systems—Lionel M. Levinson and Marshall Luban. 172, 268 (1968)
LUBITZ, C. R.
Coupled-Channel Calculation of $C^{12}$-Neutron Scattering—J. T. Reynolds, C. J. Slavik, C. R. Lubitz, and N. C. Francis. 176, 1213 (1968)
LUCAS, A. A.
Effect of Many-Body van der Waals Forces on the Lattice Dynamics of Rare-Gas Crystals—A. A. Lucas. 176, 1093 (1968)
LUCKEY, D.
Wide-Angle Electron-Positron Pair Production. K. J. Cohen, S. Homma, D. Luckey, and L. S. Osborne. 173, 1339 (1968)
LUDEMANN, C. A.
$Be^9(p,p\alpha)He^5$ Reaction at 57 MeV—P. G. Roos, H. G. Pugh, Mahavir Jain, H. D. Holmgren, Martin Epstein, and C. A. Ludemann. 176, 1246 (1968)
LUENGO, C. A.
Thermal and Electrical Conductivities of Very-High-Purity Indium—M. E. de la Cruz, F. de la Cruz, J. M. Cotignola, O. J. Bressan, and C. A. Luengo. 176, 871 (1968)
LUGHOFER, W.
Study of the $\Lambda$-$N$ System in Low-Energy $\Lambda$-$p$ Elastic Scattering—G. Alexander, U. Karshon, A. Shapira, G. Yekutieli, R. Engelmann, H. Filthuth, and W. Lughofer. 173, 1452 (1968)
LUNELL, Sten
Magnetic Hyperfine Structure of Lithium, Using an Approximate Projected Hartree-Fock Method—Sten Lunell. 173, 85 (1968)
LUNTZ, Myron
Stopping Power and Luminescent-Response Calculation for Channeling in NaI(Tl) and CsI(Tl)—Myron Luntz and Ralph H. Bartram. 175, 468 (1968)
LUO, H. L.
Magnetic Properties of Gold-Rich Gold-Vanadium Alloys—L. Creveling, Jr., and H. L. Luo. 176, 614 (1968)
LURÇAT, François
Strongly Decaying Particles and Relativistic Invariance—François Lurçat. 173, 1461 (1968)
LURIO, Allen
Hyperfine Structure and Lifetimes of the $4^2P_{3/2}$ and $5^2P_{3/2}$ States of $K^{39}$—Robert W. Schmieder, Allen Lurio, and W. Happer. 173, 76 (1968)
LUSZCZYNSKI, K.
Diffusion Coefficients and Nuclear Magnetic Susceptibility of Dilute $He^3$–He II Solutions—J. E. Opfer, K. Luszczynski, and R. E. Norberg. 172, 192 (1968)
LUTHER, Alan
Spin Relaxation and Transport in Magnetic Alloys—Peter Fulde and Alan Luther. 175, 337 (1968)
LUTTINGER, J. M.
Mean-Occupation-Number Formalism in Statistical Mechanics—J. M. Luttinger. 174, 263 (1968)
LUTZ, H. O.
Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10-180 MeV—C. D. Moak, H. O. Lutz, L. B. Bridwell, L. C. Northcliffe, and S. Datz. 176, 427 (1968)
LYNCH, D. W.
Optical Properties of Dilute Ag-In Alloys—R. M. Morgan and D. W. Lynch. 172, 628 (1968)
Photochemical Conversion of $F$ Centers to $M$ Centers in KCl, KBr, and CsBr—A. D. Brothers and D. W. Lynch. 174, 958 (1968)
Study of the $F'$ Center in Several Alkali Halides—D. W. Lynch and D. A. Robinson. 174, 1050 (1968)
LYONS, J. D.
Hyperfine Pressure Shift and van der Waals Interaction. I. Hydrogen-Helium System—Supriya Ray, J. D. Lyons, and T. P. Das. 174, 104 (1968)
Hyperfine Pressure Shift and van der Waals Interaction. II. Nitrogen-Helium System—J. D. Lyons, Supriya Ray, and T. P. Das. 174, 112 (1968)
MA, Shang-keng
Spin Waves in $He^3$ in the Paramagnon Model—Shang-keng Ma, M. T. Béal-Monod, and Donald R. Fredkin. 174, 227 (1968)
MacCRONE, R. K.
ac Dielectric Investigations of the Gyulai-Hartly Effect: Enhanced Conductivity in Alkali Halides following Plastic Deformation—M. C. Shine and R. K. MacCrone. 176, 1076 (1968)
MACFADYEN, N. W.
Pion-Nucleon Scattering and $SO(4)$ Symmetry—N. W. Macfadyen. 171, 1691 (1968)
MACFARLANE, Ronald D.
Alpha Decay of the Isomers of $^{214}$Fr—David F. Torgerson, Richard A. Gough, and Ronald D. Macfarlane. 174, 1494 (1968)

MacGREGOR, Malcolm H.
Determination of the Nucleon-Nucleon Scattering Matrix. IX. ($n$,$p$) Analysis from 7 to 750 MeV—Malcolm H. MacGregor, Richard A. Arndt, and Robert M. Wright. 173, 1272 (1968)

MacKAY, J. W.
Erratum: Subthreshold Electron Damage in $n$-Type Germanium—Y. Chen and J. W. MacKay. [167, 745 (1968)] 173, 918 (1968)
Stored-Energy Release in Electron-Irradiated Germanium—M. P. Singh and J. W. MacKay. 175, 985 (1968)

MacKELLAR, Alan D.
High-Energy Nonlocal Nucleon-Nucleus Optical Potential for a Central Two-Body Force with Second-Order Corrections to the Impulse Approximation—J. F. Reading and Alan D. MacKellar. 173, 1026 (1968)
Brueckner Theory in an Oscillator Basis. I. The Method of Reference Bethe-Goldstone Equations and Comparison of the Yale, Reid (Hard-Core), and Hamada-Johnston Interactions—Richard L. Becker, Alan D. MacKellar, and B. M. Morris. 174, 1264 (1968)

MACKEY, H. J.
Electron Transport with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey and J. R. Sybert. 172, 603 (1968)
Size Effect in the Electrical Conductivity of Cylindrical Wires—H. J. Mackey, W. D. Deering, and J. R. Sybert. 176, 856 (1968)

MACKEY, Jacob E.
$\kappa$-Meson Mass and Weak-Decay Parameters from a Study of $K_{l3}$ Form Factors—Jacob E. Mackey, J. Michael McKisic, David M. Scott, and Walter W. Wada. 172, 1590 (1968)

MacKINNON, John A.
Origin of the Crystal Field in $Ti^{3+}$-Substituted Alums—Gerald F. Dionne and John A. MacKinnon. 172, 325 (1968)

MADAN, Rabinder N.
Stationary Expectation Values and Slopes of Daughter Regge Trajectories for the Bethe-Salpeter Equation—Rabinder N. Madan, Richard W. Haymaker, and R. Blankenbecler. 172, 1788 (1968)
Upper and Lower Bounds on $s$-Wave Electron-Hydrogen Scattering. I—Rabinder N. Madan. 173, 214 (1968)
Generalized Superperturbation Theory for Scattering—Rabinder N. Madan. 173, 1615 (1968)

MADSEN, V. A.
Study of the Two-Body Force through the ($He^3$,$t$) Charge-Exchange Reaction on $O^{17}$ and $O^{18}$—Luisa F. Hansen, Marion L. Stelts, Jose G. Vidal, J. J. Wesolowski, and V. A. Madsen. 174, 1155 (1968)

MAGDE, Douglas
Optical Parametric Scattering in Ammonium Dihydrogen Phosphate—Douglas Magde and Herbert Mahr. 171, 393 (1968)

MAGNUSON, G. D.
Low-Energy (1- to 100-eV) Charge-Transfer Cross-Section Measurements for Noble-Gas-Ion Collisions with Gases—P. Mahadevan and G. D. Magnuson. 171, 103 (1968)

MAHADEVAN, P.
Low-Energy (1- to 100-eV) Charge-Transfer Cross-Section Measurements for Noble-Gas-Ion Collisions with Gases—P. Mahadevan and G. D. Magnuson. 171, 103 (1968)

MAHAN, G. D.
Phonon-Assisted Recombination of Free Excitons in Compound Semiconductors—B. Segall and G. D. Mahan. 171, 935 (1968)
Erratum: Electron Tunneling in Metal-Semiconductor Barriers—J. W. Conley, C. B. Duke, G. D. Mahan, and J. J. Tiemann. [150, 466 (1966)] 174, 1082 (1968)
Coulomb Interactions in an Atomic Dielectric—G. D. Mahan and R. M. Mazo. 175, 1191 (1968)

MAHANTI, S. D.
Theoretical Analysis of the Hyperfine Structure of Alkali Atoms—L. Tterlikkis, S. D. Mahanti, and T. P. Das. 176, 10 (1968)

MAHENDROO, P. P.
Spin-Lattice Relaxation in Pure and Europium-Doped $BaF_2$ Crystals at High and Low Temperatures—J. R. Miller and P. P. Mahendroo. 174, 369 (1968)

MAHOUX, Gilbert
Extension of Axiomatic Analyticity Properties for Particles with Spin, and Proof of Superconvergence Relations—Gilbert Mahoux and Andre Martin. 174, 2140 (1968)

MAHR, Herbert
Optical Parametric Scattering in Ammonium Dihydrogen Phosphate—Douglas Magde and Herbert Mahr. 171, 393 (1968)

MAIER, B. P. K.
Nuclear Levels in $^{142}Pr$—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)

MAJKOWSKI, R. F.
Measured Shifts of Cesium Atomic Lines—Correlation with Electron Density Derived from Widths—R. F. Majkowski and R. J. Donohue. 173, 177 (1968)

MAKI, Kazumi
High-Frequency Surface Impedance of Dirty Type-II Superconductors in the Surface-Sheath Regime—Gaston Fischer and Kazumi Maki. 176, 581 (1968)

MAKOFSKE, W.
Elastic and Inelastic Proton Scattering from Even Isotopes of Cd, Sn, and Te—W. Makofske, W. Savin, H. Ogata, and T. H. Kruse. 174, 1429 (1968)

MAKOVSKY, J.
Magnetic Structure of $NaNiF_3$—A. Epstein, J. Makovsky, M. Melamud, and H. Shaked. 174, 560 (1968)

MALIK, F. B.
Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions—Thomas C. Tucker, Louis D. Roberts, C. W. Nestor, Jr., Thomas A. Carlson, and F. B. Malik. 174, 118 (1968)
Level Spectra of Odd Isotopes of Ga, As, Br, and Rb in the Coriolis Coupling Model with a Residual Interaction of the Pairing Type—W. Scholz and F. B. Malik. 176, 1355 (1968)

MALLINSON, R. B.
de Haas–van Alphen Effect in $n$-Type $Bi_2Te_3$—R. B. Mallinson, J. A. Rayne, and R. W. Ure, Jr. 175, 1049 (1968)

MANCUSI, M. D.
$^{136}Xe(d,p)$ and $^{136}Xe(d,t)$ Reactions—P. A. Moore, P. J. Riley, C. M. Jones, M. D. Mancusi, and J. L. Foster, Jr. 175, 1516 (1968)

MANDELKERN, M.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)

MANDELSTAM, Stanley
Feynman Rules for Electromagnetic and Yang-Mills Fields from the Gauge-Independent Field-Theoretic Formalism—Stanley Mandelstam. 175, 1580 (1968)
Feynman Rules for the Gravitational Field from the Coordinate-Independent Field-Theoretic Formalism—Stanley Mandelstam. 175, 1604 (1968)
MANDULA, Jeffrey E.
Kinematical Constraints on Helicity Amplitudes—Jeffrey E. Mandula. 174, 1948 (1968)
MANFREDI, M.
Positron Annihilation in Semiconductors—R. Fieschi, A. Gainotti, C. Ghezzi, and M. Manfredi. 175, 383 (1968)
MANI, H. S.
Interference of Kaon Resonances—G. L. Kane and H. S. Mani. 171, 1533 (1968)
Decay Mode $\Sigma^0 \to \Lambda^0+\gamma+\gamma$ and the Magnetic Moment of the $\Sigma^0$—H. S. Mani and York-Peng Yao. 174, 1797 (1968)
MANNING, Robert J.
Search for a $2\pi^0$ Resonance near 730 MeV in $\pi^+ d$ Interactions—Gerald A. Smith and Robert J. Manning. 171, 1399 (1968)
MANUEL, O. K.
Xenon-134 from the Decay of Cesium-134—E. C. Alexander, Jr., G. A. Bennett, B. Srinivasan, and O. K. Manuel. 175, 1494 (1968)
MAOR, U.
Kinematical Singularities and Zeros for the Reaction $\gamma N \to VN$—E. Gotsman and U. Maor. 171, 1495 (1968)
MAPLE, M. B.
Superconductivity of α-Phase U-Mo Alloys at Zero and High Pressures—J. E. Gordon, W. E. Gardner, T. F. Smith, C. W. Chu, and M. B. Maple. 176, 556 (1968)
MAPLES, Creve C.
Observation of the Lowest $p$-Shell $T=\frac{3}{2}$ States of $^{11}$B and $^{11}$C—S. W. Cosper, Robert L. McGrath, Joseph Cerny, Creve C. Maples, George W. Goth, and Donald G. Fleming. 176, 1113 (1968)
MARADUDIN, A. A.
Calculation of the Anharmonic Damping of Rayleigh Surface Modes—A. A. Maradudin and D. L. Mills. 173, 881 (1968)
MARBURGER, J. H.
Large-Scale Self-Trapping of Optical Beams in the Paraxial Ray Approximation—W. G. Wagner, H. A. Haus, and J. H. Marburger. 175, 256 (1968)
MARCHESINI, G.
Quark Interactions and Nucleon Form Factors—G. M. Cicuta, G. Marchesini, and A. Scotti. 175, 2113 (1968)
MARCUS, J. A.
Size-Dependent Oscillatory Magnetoresistance Effect in Gallium—J. A. Munarin, J. A. Marcus, and Philip E. Bloomfield. 172, 718 (1968)
de Haas-van Alphen Effect in Antiferromagnetic Chromium—J. E. Graebner and J. A. Marcus. 175, 659 (1968)
High-Field Galvanomagnetic Effects in Antiferromagnetic Chromium—A. J. Arko, J. A. Marcus, and W. A. Reed. 176, 671 (1968)
MARGAZIOTIS, Demetrius J.
Angular Distribution of the $d(p,\pi)2p$ Reaction at 45.5 MeV—Demetrius J. Margaziotis, Byron T. Wright, and W. T. H. van Oers. 171, 1170 (1968)
MARIS, H. J.
Ultrasonic Attenuation in Dirty Dielectric Crystals—H. J. Maris. 175, 1077 (1968)
MARISCOTTI, M. A. J.
$Ba^{137}(n,\gamma)$ Reaction and Level Structure of $Ba^{138}$—M. A. J. Mariscotti, W. Gelletly, J. A. Moragues, and W. R. Kane. 174, 1485 (1968)
MARK, Hans
Measurements of $L_2$- and $L_3$-Subshell Fluorescence Yields in Heavy Elements—Richard E. Price, Hans Mark, and C. D. Swift. 176, 3 (1968)
MARKOWITZ, D.
Effect of Antimony, Indium, and Zinc Impurities on the Critical-Field Curve of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 543 (1968)
Calculation of the Effect of Superconducting Energy-Gap Anisotropy on the Thermal Conductivity of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 556 (1968)
MARLOW, Wayland C.
Measurement of the Sodium $D$-Line Absolute Oscillator Strengths by the Roschdestvenskii Hook Method—Carl A. Forbrich, Jr., Wayland C. Marlow, and Daniel Bershader. 173, 150 (1968)
MARQUARDT, Charles L.
Ionic Transport in Potassium Chloride—Robert G. Fuller, Charles L. Marquardt, Michael H. Reilly, and John C. Wells, Jr. 176, 1036 (1968)
MARRONE, M. J.
Recombination Luminescence from Self-Trapped Excitons in Ammonium Halide Crystals—M. J. Marrone and M. N. Kabler. 176, 1070 (1968)
MARSHAK, R. E.
Second-Order Weak Processes and Weak-Interaction Cutoff—R. N. Mohapatra, J. Subba Rao, and R. E. Marshak. 171, 1502 (1968)
MARSHALL, S. A.
Electron-Spin-Resonance Absorption Spectrum of Trivalent Gadolinium in Single-Crystal Calcite—S. A. Marshall and R. A. Serway. 171, 345 (1968)
MARTEL, P.
Lattice Dynamics of Niobium-Molybdenum Alloys—B. M. Powell, P. Martel, and A. D. B. Woods. 171, 727 (1968)
MARTIN, Alexander
Scalar Nonet, Semileptonic $K$ Decays, and Spectral-Function Sum Rules—Binayak Dutta-Roy and Alexander Martin. 176, 1979 (1968)
MARTIN, Andre
Extension of Axiomatic Analyticity Properties for Particles with Spin, and Proof of Superconvergence Relations—Gilbert Mahoux and Andre Martin. 174, 2140 (1968)
MARTIN, Arthur W.
Centrifugal-Barrier Effects in $N/D$ Calculations—R. W. Childers and A. W. Martin. 171, 1540 (1968)
Unitarity and the Mandelstam Representation. II. Large-Angular-Momentum Partial-Wave Amplitudes—Arthur W. Martin. 173, 1439 (1968)
Structure of Unitary Scattering Amplitudes. II.—Arthur W. Martin. 175, 2155 (1968)
MARTIN, B. D.
Heat Capacity of α-Manganese from 0.2 to 0.4°K—B. D. Martin and C. V. Heer. 173, 631 (1968)
MARTIN, B. R.
$s$-Wave $K^+p$ Dynamics—B. R. Martin. 175, 2034 (1968)
MARTIN, D. W.
Mobilities of Mass-Identified $H_3^+$ and $H^+$ Ions in Hydrogen—D. L. Albritton, T. M. Miller, D. W. Martin, and E. W. McDaniel. 171, 94 (1968)

Reactions of $H^+$ in $H_2$ and $D^+$ in $D_2$: Mobilities of Hydrogen and Alkali Ions in $H_2$ and $D_2$ Gases—T. M. Miller, J. T. Moseley, D. W. Martin, and E. W. McDaniel. 173, 115 (1968)

MARTIN, Douglas L.

Erratum: Specific Heats below 3°K of Pure Copper, Silver, and Gold and of Extremely Dilute Gold-Transition-Metal Alloys—Douglas L. Martin. [170, 650 (1968)] 174, 1062 (1968)

Specific Heat below 3°K of Silver-Gold Alloys—Douglas L. Martin. 176, 790 (1968)

MARTIN, F.

Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)

Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)

MARTON, L.

Reflectance and $1/\epsilon$ Resonance of Beryllium in the Far Ultraviolet—J. Toots, H. A. Fowler, and L. Marton. 172, 670 (1968)

MASON, D. L.

Proton-Proton Bremsstrahlung at 47 MeV—D. L. Mason, M. L. Halbert, and L. C. Northcliffe. 176, 1159 (1968)

MASSON, D.

Broken-Symmetry Model of Meson Interactions—L. A. Copley, D. K. Elias, and D. Masson. 173, 1552 (1968)

MASUDA, Naohiko

Theory of Pion-Pion Scattering—Naohiko Masuda. 175, 2087 (1968)

Threshold Behavior of Partial-Wave Dispersion Relation and Short-Range Force—Naohiko Masuda. 175, 2093 (1968)

MATATAGUI, E.

Thermoreflectance in Semiconductors—E. Matatagui, A. G. Thompson, and Manuel Cardona. 176, 950 (1968)

MATESE, J. J.

Static Nuclear Deformation Effects in Internal Conversion—J. J. Matese. 173, 1165 (1968)

MATHUR, B. S.

Light Shifts in the Alkali Atoms—B. S. Mathur, H. Tang, and W. Happer. 171, 11 (1968)

MATHUR, M. P.

Phonon-Assisted Impurity Scattering in Gold Alloys—D. H. Damon, M. P. Mathur, and P. G. Klemens. 176, 876 (1968)

MATHUR, V. S.

Anomalous Magnetic Moment of the $A_1$—V. S. Mathur and R. N. Mohapatra. 173, 1668 (1968)

Asymptotic Sum Rules for Three-Point Functions: the $A_1$-$\rho$-$\pi$ System—V. S. Mathur. 174, 1743 (1968)

MATSUDA, S.

Sum Rules from Charge-Charge-Density and Charge-Charge Commutators—S. Matsuda and S. Oneda. 171, 1743 (1968)

Derivation of Intermultiplet Mass Formulas from the Chiral $SU(3) \otimes SU(3)$ Charge Algebra—S. Matsuda and S. Oneda. 174, 1992 (1968)

Sum Rules Involving the $\rho$ and $A_1$ Mesons and the $A_1 \to \rho + \pi$ Decay—S. Matsuda and S. Oneda. 174, 2106 (1968)

MATTHIAS, E.

$g$-Factor Measurement of a Three-Particle Isomeric State of $^{209}$Po Following Pulsed Generation in $(\alpha, x\gamma)$ Reactions—T. Yamazaki and E. Matthias. 175, 1476 (1968)

MAURER, G.

Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)

Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/$c$—A. Fridman, G. Maurer, A. Michalon, J. Oudet, R. Straub, C. Voltolini, and P. Cüer. 176, 1595 (1968)

MAZAKI, Hiromasa

Single-Quantum Annihilation of Positrons—Hiromasa Mazaki, Masatsugu Nishi, and Sakae Shimizu. 171, 408 (1968)

MAZO, R. M.

Coulomb Interactions in an Atomic Dielectric—G. D. Mahan and R. M. Mazo. 175, 1191 (1968)

McALISTER, A. J.

Search for Plasmaron Structure in the Soft X-Ray $L_{2,3}$ Emission Spectrum of Al—J. R. Cuthill, R. C. Dobbyn, A. J. McAlister, and M. L. Williams. 174, 515 (1968)

McCARTHY, J. S.

Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)

McCARTHY, K. A.

Orientation Dependence of Ultrasonic Attenuation in Copper—E. Y. Wang, R. J. Kolouch, and K. A. McCarthy. 175, 723 (1968)

McCARTOR, G. D.

Extension of the Contour-Distortion Method in Relativistic Three-Particle Scattering—G. D. McCartor and J. Nuttall. 171, 1627 (1968)

McCAUGHEY, M. P.

Coincidence Measurements of Krypton-Krypton Collisions—M. P. McCaughey, E. J. Knystautas, and E. Everhart. 175, 14 (1968)

McCOY, Barry M.

Spin Correlation Functions of the $X$-$Y$ Model—Barry M. McCoy. 173, 531 (1968)

Theory of Toeplitz Determinants and the Spin Correlations of the Two-Dimensional Ising Model. V—Barry M. McCoy and Tai Tsun Wu. 174, 546 (1968)

Theory of a Two-Dimensional Ising Model with Random Impurities. I. Thermodynamics—Barry M. McCoy and Tai Tsun Wu. 176, 631 (1968)

McCUMBER, D. E.

Intrinsic Resistive Transition in Thin Superconducting Wires Driven from Current Sources—D. E. McCumber. 172, 427 (1968)

dc Josephson Effect for Strong-Coupling Superconductors—T. A. Fulton and D. E. McCumber. 175, 585 (1968)

McDANIEL, E. W.

Mobilities of Mass-Identified $H_3^+$ and $H^+$ Ions in Hydrogen—D. L. Albritton, T. M. Miller, D. W. Martin, and E. W. McDaniel. 171, 94 (1968)

Reactions of $H^+$ in $H_2$ and $D^+$ in $D_2$: Mobilities of Hydrogen and Alkali Ions in $H_2$ and $D_2$ Gases—T. M. Miller, J. T. Moseley, D. W. Martin, and E. W. McDaniel. 173, 115 (1968)

McDANIELS, D. K.

Lifetimes, Energies, and Branching Ratios of $^{28}$Si Excited States—E. F. Gibson, K. Battleson, and D. K. McDaniels. 172, 1004 (1968)

Lifetime Measurements from the $K^{39}(p,\gamma)Ca^{40}$ Reaction—K. W. Dolan and D. K. McDaniels. 175, 1446 (1968)

McDONALD, R. E.
$Ne^{22}(t,p\gamma)Ne^{24}$ Angular Correlation Study—J. A. Becker, L. F. Chase, Jr., R. E. McDonald, and E. K. Warburton. 176, 1310 (1968)

McDONALD, S. C.
Wave Equations on a Hyperplane—C. L. Hammer, S. C. McDonald, and D. L. Pursey. 171, 1349 (1968)

McDONALD, W. J.
Energy Levels of $^{46}$Sc—W. J. McDonald, J. T. Sample, D. M. Sheppard, G. M. Stinson, and K. W. Jones. 171, 1254 (1968)

McDONNELL, Michael
K-x-Ray–$\gamma$-Ray Directional Correlation in the Decay of $Ba^{133}$—Michael McDonnell and M. K. Ramaswamy. 171, 1278 (1968)

McDOWELL, M. R. C.
Elastic Scattering of Slow Electrons by Two-Electron Ions—M. R. C. McDowell. 175, 189 (1968)
Photo-Ionization of Lithium: A Many-Body Calculation—Edward S. Chang and M. R. C. McDowell. 176, 126 (1968)

McELLISTREM, M. T.
Proton-Induced Reactions on $^{40}$Ar and Analogs of $^{41}$Ar Levels—H. L. Scott, W. Galati, J. L. Weil, and M. T. McEllistrem. 172, 1139 (1968)

McGAHAN, J. T.
Compilation of $\pi^- p$ Data at 4 GeV/c: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

McGILL, Richard E.
Vibrations of Disordered Solids—Herbert B. Rosenstock and Richard E. McGill. 176, 1004 (1968)

McGOWAN, J. William
Lyman-$\alpha$ Production and Polarization in $He^+$ Collisions with H and $H_2$—Robin A. Young, R. F. Stebbings, and J. William McGowan. 171, 85 (1968)

McGRATH, Robert L.
Observation of the Lowest $p$-Shell $T=\frac{3}{2}$ States of $^{11}$B and $^{11}$C—S. W. Cosper, Robert L. McGrath, Joseph Cerny, Creve C. Maples, George W. Goth, and Donald G. Fleming. 176, 1113 (1968)

McGUIRE, Eugene J.
Photo-Ionization Cross Sections of the Elements Helium to Xenon—Eugene J. McGuire. 175, 20 (1968)

McHARRIS, Wm. C.
High-Resolution Gamma-Ray Spectroscopic Studies of the Decays of 2.6-h $Nd^{141g}$ and 60-sec $Nd^{141m}$—D. B. Beery, W. H. Kelly, and Wm. C. McHarris. 171, 1283 (1968)

McHUGH, J. A.
Fission-Fragment Mass and Charge Distribution for the Moderately Excited $U^{236}$ Compound Nucleus—J. A. McHugh and M. C. Michel. 172, 1160 (1968)

McISAAC, L. D.
Levels in $^{133}$I from the Decay of $^{133m}$Te and $^{133g}$Te—L. D. McIsaac. 172, 1253 (1968)

McKELLAR, Bruce H. J.
Polarization Effects in $(d,p)$ Reactions According to the Butler-Hewitt-McKellar-May Theory—Bruce H. J. McKellar. 171, 1137 (1968)
Green's Velocity-Dependent Potential in the Shell Model of $Po^{210}$, $Pb^{210}$, and $Bi^{210}$—P. S. Ganas and Bruce H. J. McKellar. 175, 1409 (1968)

McKISIC, J. Michael
$\kappa$-Meson Mass and Weak-Decay Parameters from a Study of $K_{l3}$ Form Factors—Jacob E. Mackey, J. Michael McKisic, David M. Scott, and Walter W. Wada. 172, 1590 (1968)

McLEAN, W. L.
Magnetic-Field Dependence of Radio-Frequency Flux Penetration in Type-II Superconductors—D. E. Carlson and W. L. McLean. 176, 538 (1968)

McLENNAN, James A.
Correlation Functions as Hydrodynamic Green's Functions—James W. Dufty and James A. McLennan. 172, 176 (1968)

McMILLAN, W. L.
Theory of Strongly Interacting Quantum Liquids. I. Formulation—W. L. McMillan. 175, 266 (1968)
Tunneling Model of the Superconducting Proximity Effect—W. L. McMillan. 175, 537 (1968)
Theory of Superconductor–Normal-Metal Interfaces—W. L. McMillan. 175, 559 (1968)

McNULTY, P. J.
Relativistic Energy Loss by Ionization in Nuclear Emulsions—F. J. Congel and P. J. McNulty. 176, 1615 (1968)
Erratum: Ionization Loss at Relativistic Velocities—C. A. Nicoletta, P. J. McNulty, and P. L. Jain. [164, 1693 (1967)] 176, 2167 (1968)

MEADOWS, J. W., Jr.
Nuclear Pairing Energy of Transition Nucleus $Pu^{240}$—J. R. Huizenga, A. N. Behkami, J. W. Meadows, Jr., and E. D. Klema. 174, 1539 (1968)

MEBS, R. W.
Solute Knight Shifts in Noble Metals—Lawrence H. Bennett, R. W. Mebs, and R. E. Watson. 171, 611 (1968)

MEDICUS, H. A.
Fast-Photoneutron Spectra due to 55–85-MeV Photons—N. N. Kaushal, E. J. Winhold, P. F. Yergin, H. A. Medicus, and R. H. Augustson. 175, 1330 (1968)

MEGGS, W. J.
Eigenvectors for the Partial-Wave "Crossing Matrices"—A. P. Balachandran, W. J. Meggs, and P. Ramond. 175, 1974 (1968)
Simultaneous Partial-Wave Expansion in the Mandelstam Variables: The Group $SU(3)$—A. P. Balachandran, W. J. Meggs, J. Nuyts, and P. Ramond. 176, 1700 (1968)

MEHENDRU, P. C.
Effect of Optical and Thermal Bleaching on the uv Bands in Highly Pure and Mn-Doped KCl Crystals—P. C. Mehendru and Ved Mitra. 176, 1089 (1968)

MEHLHOP, W. A. W.
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)

MEHR, F. J.
Electron-Temperature Dependence of Electron-Ion Recombination in Argon—F. J. Mehr and Manfred A. Biondi. 176, 322 (1968)

MEHTA, G. K.
Effective Interaction for Light and Intermediate Nuclei—K. P. Joshi, G. K. Mehta, and Y. R. Waghmare. 176, 1154 (1968)

MEIERE, F. T.
Renormalization of the Strangeness-Changing Axial-Vector Coupling Constants—C. H. Chan and F. T. Meiere. 175, 2222 (1968)

MEISTRICH, Marvin L.
Optical and Electron-Spin-Resonance Studies of the $ICl^-$ $V_K$ Center in KCl:I—Lawrence S. Goldberg and Marvin L. Meistrich. 172, 877 (1968)

MELAMUD, M.
Magnetic Structure of $NaNiF_3$—A. Epstein, J. Makovsky, M. Melamud, and H. Shaked. 174, 560 (1968)

MELTZER, C. M.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

MELVIN, J. S.
Lattice Dynamics and Ionic Deformation in Some Alkali Halides—J. S. Melvin, J. D. Pirie, and T. Smith. 175, 1082 (1968)

MENDELSOHN, Lawrence B.
High-Order Perturbation Theory for a One-Electron Ion in a Uniform Electric Field—Lawrence B. Mendelsohn. 176, 90 (1968)

MENDLOWITZ, H.
Quantum Theory of the Smith-Purcell Experiment—Solomon J. Glass and H. Mendlowitz. 174, 57 (1968)

MENOTTI, P.
Asymptotic Behavior of Form Factors for Some Composite Models—M. Ciafaloni and P. Menotti. 173, 1575 (1968)

MERKEL, G.
Influence of Angular Momentum on the Decay of the $Ni^{60}$ Compound Nucleus—J. Benveniste, G. Merkel, and A. Mitchell. 174, 1357 (1968)

MERMIN, N. D.
Exact Lower Bounds for Some Equilibrium Properties of a Classical One-Component Plasma—N. D. Mermin. 171, 272 (1968)
Crystalline Order in Two Dimensions—N. D. Mermin. 176, 250 (1968)

MERZ, J. L.
Isoelectronic Oxygen Trap in ZnTe—J. L. Merz. 176, 961 (1968)

MESHII, M.
Determination of the Number of Unique Configurations of Unrelaxed Clusters in Crystal Lattices—A. P. Brody and M. Meshii. 176, 845 (1968)

MESHKOV, S.
$SU(6)_W$ and High-Energy Photoproduction—S. Meshkov and R. Ponzini. 175, 2030 (1968)

METZ, R.
On the Theory of Quantized Vortices—G. V. Chester, R. Metz, and L. Reatto. 175, 275 (1968)

METZGER, F. R.
Nuclear Resonance Fluorescence in $Cu^{65}$—F. R. Metzger. 171, 1257 (1968)

MEYER, Horst
Observation of Pair Interaction between Ortho Molecules in Solid $H_2$—A. Brooks Harris, Larry I. Amstutz, Horst Meyer, and Samuel M. Myers. 175, 603 (1968)

MEYER, James W.
Off-Mass-Shell Approach to Nucleon Resonances of Spin $\frac{3}{2}$ and Isospin $\frac{1}{2}$—Masao Sugawara and James W. Meyer. 174, 1709 (1968)

MEYER, R. A.
Transitional Nuclei. II. Higher Vibrational States in Nucleus $^{154}Gd$—R. A. Meyer. 174, 1478 (1968)

MICHAEL, C.
Regge Poles and Finite-Energy Sum Rules for Kaon-Nucleon Scattering—Guru Vachan Dass and C. Michael. 175, 1774 (1968)

MICHALON, A.
Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/$c$—A. Fridman, G. Maurer, A. Michalon, J. Oudet, R. Straub, C. Voltolini, and P. Cüer. 176, 1595 (1968)

MICHEL, M. C.
Fission-Fragment Mass and Charge Distribution for the Moderately Excited $U^{236}$ Compound Nucleus—J. A. McHugh and M. C. Michel. 172, 1160 (1968)

MIDDLEMAS, N.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

MIEHER, Robert Lee
Electron-Nuclear Double Resonance of the Self-Trapped Hole in LiF—Ramayana Gazzinelli and Robert Lee Mieher. 175, 395 (1968)
Electron-Nuclear Double-Resonance Spectrum of the $V_K$ Center in Sodium Fluoride—Daniel F. Daly and Robert Lee Mieher. 175, 412 (1968)
Electron-Nuclear Double-Resonance Study of the Self-Trapped Hole Associated with Lithium in NaF—Isaac L. Bass and Robert Lee Mieher. 175, 421 (1968)

MIES, Frederick H.
Configuration Interaction Theory. Effects of Overlapping Resonances—Frederick H. Mies. 175, 164 (1968)

MIHARA, N.
Liquid Structure Factor of Ground-State $He^4$—N. Mihara and R. D. Puff. 174, 221 (1968)

MILLER, C. E.
Nuclear Spin-Lattice Relaxation in Very Dilute Solutions of Orthohydrogen in Parahydrogen—C. E. Miller and M. Lipsicas. 176, 273 (1968)

MILLER, J. M.
Study of the Particles Emitted from $Br^{75}$ Compound Nuclei Formed in Two Ways: $C^{12} + Cu^{63}$ and $O^{16} + Co^{59}$—J. M. D'Auria, M. J. Fluss, G. Herzog, L. Kowalski, J. M. Miller, and R. C. Reedy. 174, 1409 (1968)
Effects of Using a Velocity-Dependent Potential in a Monte Carlo Simulation of Intranuclear Cascades—K. Chen, G. Friedlander, and J. M. Miller. 176, 1208 (1968)

MILLER, J. R.
Spin-Lattice Relaxation in Pure and Europium-Doped $BaF_2$ Crystals at High and Low Temperatures—J. R. Miller and P. P. Mahendroo. 174, 369 (1968)

MILLER, James T.
Coupling between the Poincaré Group and Space-Time or Spacelike Reflections on Hyperplanes—James T. Miller, Jr., and Gordon N. Fleming. 174, 1625 (1968)

MILLER, M. D.
Nucleon-Nucleon Models, Charge Splitting, and the Nucleon-Nucleon Data near 210 MeV—M. D. Miller, P. S. Signell, and N. R. Yoder. 176, 1724 (1968)

MILLER, P. B.
Phonons in Time-Dependent Hartree Approximation with Application to Order-Disorder Ferroelectrics—P. B. Miller and P. C. Kwok. 175, 1062 (1968)

MILLER, R. E.
Magnetic Transitions of Superconducting Thin Films and Foils. I. Lead—G. D. Cody and R. E. Miller. 173, 481 (1968)
Magnetic Transitions of Superconducting Thin Films and Foils. II. Tin—R. E. Miller and G. D. Cody. 173, 494 (1968)

MILLER, S. A.
Infrared Dispersion and Lattice Vibrations of $LaF_3$—H. E. Rast, H. H. Caspers, S. A. Miller, and R. A. Buchanan. 171, 1051 (1968)

MILLER, T. M.
Mobilities of Mass-Identified $H_3^+$ and $H^+$ Ions in Hydrogen—D. L. Albritton, T. M. Miller, D. W. Martin, and E. W. McDaniel. 171, 94 (1968)
Reactions of $H^+$ in $H_2$ and $D^+$ in $D_2$: Mobilities of Hydrogen and Alkali Ions in $H_2$ and $D_2$ Gases—T. M. Miller, J. T. Moseley, D. W. Martin, and E. W. McDaniel. 173, 115 (1968)

MILLS, D. L.
Surface Effects in the Heisenberg Antiferromagnet—D. L. Mills and W. M. Saslow. 171, 488 (1968)
Calculation of the Anharmonic Damping of Rayleigh Surface Modes—A. A. Maradudin and D. L. Mills. 173, 881 (1968)
Erratum: Surface Effects in the Heisenberg Antiferromagnet—D. L. Mills and W. M. Saslow. [171, 488 (1968)] 176, 760 (1968)

MINGAY, D. W.
Nonexistence of the 14.6-MeV State in $Be^7$—P. D. Parker, D. W. Mingay, and J. C. Overley. 176, 1211 (1968)

MINKIEWICZ, V. J.
Phonon Spectrum of hcp $He^4$—V. J. Minkiewicz, T. A. Kitchens, F. P. Lipschultz, R. Nathans, and G. Shirane. 174, 267 (1968)

MIRES, Raymond W.
Low-Temperature Magnetic Anisotropy in $Al_2O_3:V^{3+}$—Alfred R. Smith and Raymond W. Mires. 172, 265 (1968)
Erratum: Semiempirical Electron Correlation in the Carbon Atom—Raymond W. Mires. [155, 1 (1967)] 174, 329 (1968)

MIRZA, I. M.
Measurements of the Electron Impact Excitation Cross Section of $N_2^+$ First Negative Bands—B. N. Srivastava and I. M. Mirza. 176, 137 (1968)

MISCHKE, R. E.
Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)

MISRA, S. P.
Quark Model and Masses of Baryons and Mesons—S. P. Misra and C. V. Sastry. 172, 1402 (1968)

MISTRETTA, C. A.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)

MISTRY, V. C.
Proton and Neutron Resonances in Nitrogen—F. Boreli, P. N. Shrivastava, B. B. Kinsey, and V. C. Mistry. 174, 1221 (1968)

MITCHELL, A.
Influence of Angular Momentum on the Decay of the $Ni^{60}$ Compound Nucleus—J. Benveniste, G. Merkel, and A. Mitchell. 174, 1357 (1968)

MITCHELL, D. J.
Asymptotic Behavior of the Pair Distribution Function of a Classical Electron Gas—D. J. Mitchell and B. W. Ninham. 174, 280 (1968)

MITRA, A. N.
Pion Production, Current Algebra, and Coupling-Constant Relations—A. N. Mitra and R. Nath. 171, 1798 (1968)
Paraquarks, Structural Saturation, and Hard Core—A. N. Mitra and S. A. Moszkowski. 172, 1474 (1968)
Consequences of a $QQ\bar{Q}$ Model for Meson-Baryon Processes—S. Das Gupta, V. K. Gupta, and A. N. Mitra. 172, 1482 (1968)
Rescattering Effects in the Quark Model for Meson-Baryon Couplings—J. D. Anand, V. S. Bhasin, and A. N. Mitra. 176, 1891 (1968)

MITRA, S. S.
Application of a Modified Random-Element-Isodisplacement Model to Long-Wavelength Optic Phonons of Mixed Crystals—I. F. Chang and S. S. Mitra. 172, 924 (1968)
Optical Phonons of Yttrium Aluminum Garnet—J. P. Hurrell, S. P. S. Porto, I. F. Chang, S. S. Mitra, and R. P. Bauman. 173, 851 (1968)
Pressure Dependence of Infrared Eigenfrequencies of KCl and KBr—C. Postmus, J. R. Ferraro, and S. S. Mitra. 174, 983 (1968)

MITRA, Ved
Effect of Optical and Thermal Bleaching on the uv Bands in Highly Pure and Mn-Doped KCl Crystals—P. C. Mehendru and Ved Mitra. 176, 1089 (1968)

MITTLEMAN, Marvin H.
Critical Assessment of the Polarized-Orbital Method in Atomic Scattering—Marvin H. Mittleman and Jerry L. Peacher. 173, 160 (1968)
Formal Problems in the Theory of Dissociative Attachment and Recombination—Joseph C. Y. Chen and Marvin H. Mittleman. 174, 185 (1968)
Rotational Excitation of Polar Molecules by Electrons—M. H. Mittleman and J. L. Peacher and B. F. Rozsnyai. 176, 180 (1968)

MIYATA, N.
Magnetoelastic Behavior of Europium Oxide. II. Magnetostriction and the λ Anomaly—B. E. Argyle and N. Miyata. 171, 555 (1968)

MOAK, C. D.
Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10-180 MeV—C. D. Moak, H. O. Lutz, L. B. Bridwell, L. C. Northcliffe, and S. Datz. 176, 427 (1968)

MODENA, I.
Mobility of Positive and Negative Charges in $^3He$ at the Critical Point—R. Cantelli, I. Modena, and F. P. Ricci. 171, 236 (1968)

MOFFAT, J. W.
Dipole ρ Meson, Nucleon Form Factors, and Charge-Exchange Scattering—R. E. Kreps and J. W. Moffat. 175, 1942 (1968)
Nucleon and Pion Form Factors and the Dipole ρ Meson—R. E. Kreps and J. W. Moffat. 175, 1945 (1968)

MOHAN, Gyan
Interacting Rarita-Schwinger Field—Gyan Mohan. 176, 1931 (1968)

MOHAPATRA, R. N.
Second-Order Weak Processes and Weak-Interaction Cutoff—R. N. Mohapatra, J. Subba Rao, and R. E. Marshak. 171, 1502 (1968)

Anomalous Magnetic Moment of the $A_1$—V. S. Mathur and R. N. Mohapatra. 173, 1668 (1968)

MOLDAUER, P. A.
Resonance Widths and Spacings: Their Averages and Distributions—P. A. Moldauer. 171, 1164 (1968)

MOLL, J. L.
Location of the $L_1$ and $X_3$ Minima in GaAs as Determined by Photoemission Studies—L. W. James, R. C. Eden, J. L. Moll, and W. E. Spicer. 174, 909 (1968)

MOLLOW, B. R.
Two-Photon Absorption and Field Correlation Functions—B. R. Mollow. 175, 1555 (1968)

MONAHAN, J. E.
Small-Angle Scattering of Neutrons by Heavy Nuclei—F. T. Kuchnir, A. J. Elwyn, J. E. Monahan, A. Langsdorf, Jr., and F. P. Mooring. 176, 1405 (1968)

MONGAN, Thomas R.
Separable-Potential Fits to Nucleon-Nucleon Scattering Data—Thomas R. Mongan. 175, 1260 (1968)

MONOD, P.
Transmission Electron Spin Resonance in Dilute Copper-Chromium Alloys—P. Monod and S. Schultz. 173, 645 (1968)

MOON, K. J.
Reaction $T(^3He,\gamma)^6Li$ in the Energy Range 0.5-11 MeV—S. L. Blatt, A. M. Young, S. C. Ling, K. J. Moon, and C. D. Porterfield. 176, 1147 (1968)

MOON, R. M.
Note on the Scattering Cross Sections of the Isotopes of Dysprosium—H. R. Child, L. J. Raubenheimer, W. C. Koehler, and R. M. Moon. 174, 1553 (1968)

Magnetic Structures of $Er_2O_3$ and $Yb_2O_3$—R. M. Moon, W. C. Koehler, H. R. Child, and L. J. Raubenheimer. 176, 722 (1968)

MOORE, C. A.
Optical Spectrum and Zeeman Effect of $CaF_2:Eu^{2+}$—P. Kisliuk, H. H. Tippins, C. A. Moore, and S. A. Pollack. 171, 336 (1968)

MOORE, C. Fred
Isobaric-Analog Study of $^{90}Zr$—K. P. Lieb, James J. Kent, and C. Fred Moore. 175, 1482 (1968)

Isobaric Analog Resonances in Proton Scattering from $^{124}Te$, $^{126}Te$, $^{128}Te$, and $^{130}Te$—J. L. Foster, Jr., P. J. Riley, and C. Fred Moore. 175, 1498 (1968)

MOORE, John H., Jr.
Rotational Excitation in Ion-Molecule Collisions: The System $H_2^+ + N_2$—John H. Moore, Jr. and John P. Doering. 174, 178 (1968)

MOORE, M. A.
Critical Behavior of the Ising, $XY$, and Heisenberg Ferromagnets on the $B$-Site Spinel Lattice—David Jasnow and M. A. Moore. 176, 751 (1968)

MOORE, P. A.
$^{136}Xe(d,p)$ and $^{136}Xe(d,t)$ Reactions—P. A. Moore, P. J. Riley, C. M. Jones, M. D. Mancusi, and J. L. Foster, Jr. 175, 1516 (1968)

MOORHEAD, J. B.
$g_{1/2}$-$h_{11/2}$ Anomaly in Stripping Studies near $A=110$—B. L. Cohen, R. A. Moyer, J. B. Moorhead, L. H. Goldman, and R. C. Diehl. 176, 1401 (1968)

MOORING, F. P.
Small-Angle Scattering of Neutrons by Heavy Nuclei—F. T. Kuchnir, A. J. Elwyn, J. E. Monahan, A. Langsdorf, Jr., and F. P. Mooring. 176, 1405 (1968)

MOOS, H. W.
Absorption Spectrum of Optically Pumped $Al_2O_3:Cr^{3+}$—J. W. Huang and H. W. Moos. 173, 440 (1968)

Multiphonon Orbit-Lattice Relaxation of Excited States of Rare-Earth Ions in Crystals—L. A. Riseberg and H. W. Moos. 174, 429 (1968)

Effective Density of Phonon States for $NdCl_3$ from Vibronic Spectra and Applications to Ion-Lattice Interactions—E. Cohen, L. A. Riseberg, and H. W. Moos. 175, 521 (1968)

MOO-YOUNG, G. A.
Measurements of the Stark Broadening of Two Neutral Helium Lines in a Plasma—J. R. Greig, C. P. Lim, G. A. Moo-Young, G. Palumbo, and Hans R. Griem. 172, 148 (1968)

MORAGUES, J. A.
Time Dependence of Mössbauer Scattered Radiation—P. Thieberger, J. A. Moragues, and A. W. Sunyar. 171, 425 (1968)

$Ba^{137}(n,\gamma)$ Reaction and Level Structure of $Ba^{138}$—M. A. J. Mariscotti, W. Gelletly, J. A. Moragues, and W. R. Kane. 174, 1485 (1968)

MORAVCSIK, Michael J.
Can the Parity of the $\Omega^-$ Be Measured?—G. L. Kane and Michael J. Moravcsik. 176, 1733 (1968)

MORGAN, C. G.
Scattering of Medium-Energy Alpha Particles. I. Phenomenological Analysis of Elastic Scattering—Daphne F. Jackson and C. G. Morgan. 175, 1402 (1968)

MORGAN, R. M.
Optical Properties of Dilute Ag-In Alloys—R. M. Morgan and D. W. Lynch. 172, 628 (1968)

MORITA, Tohru
Application of the Cluster Variation Method to the $s$-$d$ Interaction Hamiltonian—James Halow, Tomoyasu Tanaka, and Tohru Morita. 175, 680 (1968)

MORK, Kjell J.
Exact Calculation of Pair Production—Ingjald Øverbø, Kjell J. Mork, and Haakon A. Olsen. 175, 1978 (1968)

MORRIS, B. M.
Brueckner Theory in an Oscillator Basis. I. The Method of Reference Bethe-Goldstone Equations and Comparison of the Yale, Reid (Hard-Core), and Hamada-Johnston Interactions—Richard L. Becker, Alan D. MacKellar, and B. M. Morris. 174, 1264 (1968)

MORRIS, R. C.
Experiments with Tunnel Junctions Using Ferromagnetic Metals—J. E. Christopher, R. V. Coleman, Acar Isin, and R. C. Morris. 172, 485 (1968)

MORRISON, G. C.
Gamma Decay of $T=\frac{1}{2}$ States in $Al^{25}$ and $P^{29}$—G. C. Morrison, D. H. Youngblood, R. C. Bearse, and R. E. Segel. 174, 1366 (1968)

MORROW, Richard A.
Proposed Test of Toller $\omega$ Dependence of Two-Reggeon–One-Particle Vertex Functions—Richard A. Morrow. 176, 2147 (1968)

MORTON, J. R.
Paramagnetic-Resonance Spectra of $S^-$ Trapped in Alkali Halide Crystals—L. E. Vannotti and J. R. Morton. 174, 448 (1968)

MOSELEY, J. T.
Reactions of $H^+$ in $H_2$ and $D^+$ in $D_2$: Mobilities of Hydrogen and Alkali Ions in $H_2$ and $D_2$ Gases—T. M. Miller, J. T. Moseley, D. W. Martin, and E. W. McDaniel. 173, 115 (1968)

MOSES, E. J.
Deck-Model Calculation for Doubly Charged $K\pi\pi$ Systems in $KN \to K^+\pi N$ Reactions—F. Bomse and E. J. Moses. 176, 2163 (1968)

MOSS, C. E.
Spins of Levels in $^{33}$P—C. E. Moss, R. V. Poore, N. R. Roberson, and D. R. Tilley. 174, 1333 (1968)
MOSS, R. W.
Ultrasonic Attenuation near the Critical Point of $MnF_2$—J. R. Neighbours and R. W. Moss. 173, 542 (1968)
MOSS, S. C.
Correlation Functions of Disordered Binary Alloys. II—Philip C. Clapp and S. C. Moss. 171, 754 (1968)
Correlation Functions of Disordered Binary Alloys. III—S. C. Moss and Philip C. Clapp. 171, 764 (1968)
Neutron Measurement of Clustering in the Alloy CuNi—B. Mozer, D. T. Keating, and S. C. Moss. 175, 868 (1968)
MOSTELLER, L. P., Jr.
Optical Properties of Zn—L. P. Mosteller, Jr. and F. Wooten. 171, 743 (1968)
MOSZKOWSKI, S. A.
Paraquarks, Structural Saturation, and Hard Core—A. N. Mitra and S. A. Moszkowski. 172, 1474 (1968)
MOTCHANE, J. L.
Unitary Theory of Dynamic Polarization of Nuclear Spins in Liquids and Solids—P. Papon, J. L. Motchane, and J. Korringa. 175, 641 (1968)
MOTEFF, J.
High-Temperature Recovery of Tungsten after Neutron Irradiation—L. K. Keys, J. P. Smith, and J. Moteff. 176, 851 (1968)
MOTLEY, R. W.
Measurement of Volume Recombination Coefficients in Highly Ionized Alkali Plasmas—S. von Goeler, R. W. Motley, and R. Ellis. 172, 162 (1968)
MOTZ, J. W.
Inelastic Scattering Cross Sections for 200- and 400-keV Electrons—C. E. Dick and J. W. Motz. 171, 75 (1968)
MOULTON, W. G.
$I^{127}$ Nuclear Quadrupole Resonance in Antiferromagnetic $UI_3$—S. I. Parks and W. G. Moulton. 173, 333 (1968)
MOYER, R. A.
$s_{1/2}$-$h_{11/2}$ Anomaly in Stripping Studies near $A$=110—B. L. Cohen, R. A. Moyer, J. B. Moorhead, L. H. Goldman, and R. C. Diehl. 176, 1401 (1968)
MOYZIS, J. A., Jr.
Effect of Pressure on the Isomer Shift of $Fe^{57}$ in the bcc Phase—J. A. Moyzis, Jr., and H. G. Drickamer. 171, 389 (1968)
Effect of Pressure on $f$ Number and Isomer Shift for $Fe^{57}$ in Cu, V, and Ti—J. A. Moyzis, Jr., G. DePasquali, and H. G. Drickamer. 172, 665 (1968)
MOZER, B.
Neutron Measurement of Clustering in the Alloy CuNi—B. Mozer, D. T. Keating, and S. C. Moss. 175, 868 (1968)
MUELLER, A. H.
$O(4)$, Off-Shell $N\bar{N}$ Scattering, and Massless Pions—A. H. Mueller. 172, 1516 (1968)
MUELLER, F. M.
Anomalous Thermal Conductivity of Superconductors due to Impurity Spin Ordering—K. H. Bennemann and F. M. Mueller. 176, 546 (1968)
MUELLER, K. A.
Effective-Spin Hamiltonian for "Non-Kramers" Doublets—K. A. Mueller. 171, 350 (1968)
MUETHER, H. R.
Resonant and Nonresonant Capture of Slow Neutrons in $Tm^{169}(n,\gamma)Tm^{170}$—M. A. Lone, R. E. Chrien, O. A. Wasson, M. Beer, M. R. Bhat, and H. R. Muether. 174, 1512 (1968)
MUGHABGHAB, S. F.
Neutron Cross Sections and Resonance Parameters of Yb Isotopes—S. F. Mughabghab and R. E. Chrien. 174, 1400 (1968)
MUIR, A. H., Jr.
Determination of the Nuclear Quadrupole Moment of $Fe^{57m}$ from $\alpha$-$Fe_2O_3$ Data—J. O. Artman, A. H. Muir, Jr., and H. Wiedersich. 173, 337 (1968)
MUKOYAMA, Takeshi
Radiationless Annihilation of Positrons in Lead—Sakae Shimizu, Takeshi Mukoyama, and Yasuyuki Nakayama. 173, 405 (1968)
MULAZZI, E.
Vibrational Structures Accompanying the Optic Transitions of Bound Electrons in Crystals—E. Mulazzi, G. F. Nardelli, and N. Terzi. 172, 847 (1968)
MULDAWER, L.
Optical Properties of Free-Electron-Like Foils—R. J. Esposito, Philip E. Bloomfield, and L. Muldawer. 176, 886 (1968)
MULLEN, James G.
Direct Observation of Solid-State Diffusion Using the Mössbauer Effect—Robert C. Knauer and James G. Mullen. 174, 711 (1968)
MÜLLENSIEFEN, A.
Pion Photoproduction and Fixed-$t$ Dispersion Relations—J. Engels, A. Müllensiefen, and W. Schmidt. 175, 1951 (1968)
MÜLLER, K. A.
Stable Potential Minima and the Jahn-Teller Interaction—P. Wysling and K. A. Müller. 173, 327 (1968)
Paramagnetic Resonance of $Cr^{3+}$ in the Layer Structure of $NaInS_2$—K. A. Müller and W. Berlinger. 175, 503 (1968)
MUNARIN, J. A.
Size-Dependent Oscillatory Magnetoresistance Effect in Gallium—J. A. Munarin, J. A. Marcus, and Philip E. Bloomfield. 172, 718 (1968)
Doppler-Shifted Acoustic Cyclotron Resonance in Gallium—J. A. Munarin. 172, 737 (1968)
MÜNCHEN
Photoproduction of Meson and Baryon Resonances at Energies up to 5.8 GeV—Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration. 175, 1669 (1968)
MURPHY, F. V.
Charge-Exchange Scattering of $K^+$ Mesons from Beryllium at 0.97 BeV/$c$—J. Gezelter, G. L. Salmon, F. V. Murphy, G. K. O'Neill, and R. Grismore. 173, 1315 (1968)
MURTAS, G. P.
Proton Compton Effect by Polarized Photons at 90° in the c.m. System in the First Resonance Region—G. Barbellini, G. Capon, G. De Zorzi, and G. P. Murtas. 174, 1665 (1968)
MURTY, S. S.
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)
MUSHER, Jeremy I.
Perturbation-Theoretic Approach to Atoms and Molecules—Jeremy I. Musher and Jerome M. Schulman. 173, 93 (1968)
Accurate Atomic and Molecular Wave Functions Without Exchange—Jeremy I. Musher and Robert Silbey. 174, 94 (1968)
MUTA, Taizo
Inelastic Contribution to the $\rho$-$\pi$ Mass Difference in Cottingham's Formula—Taizo Muta. 171, 1661 (1968)

MYERS, Samuel M.
Observation of Pair Interaction between Ortho Molecules in Solid $H_2$—A. Brooks Harris, Larry I. Amstutz, Horst Meyer, and Samuel M. Myers. 175, 603 (1968)
NAHUM, J.
Optical Properties and Formation Kinetics of $M^+$ Centers in NaF—J. Nahum. 174, 1000 (1968)
NAKAI, M. Y.
Measurement of High-Energy Charge-Transfer Cross Sections for Incident Protons and Atomic Hydrogen in Various Gases—L. H. Toburen, M. Y. Nakai, and R. A. Langley. 171, 114 (1968)
NAKAYAMA, Yasuyuki
Radiationless Annihilation of Positrons in Lead—Sakae Shimizu, Takeshi Mukoyama, and Yasuyuki Nakayama. 173, 405 (1968)
NAMBU, Yoichiro
Scalar Fields Coupled to the Trace of the Energy-Momentum Tensor—Peter G. O. Freund and Yoichiro Nambu. 174, 1741 (1968)
NARATH, Albert
Effects of Electron–Electron Interactions on Nuclear Spin-Lattice Relaxation Rates and Knight Shifts in Alkali and Noble Metals—Albert Narath and H. T. Weaver. 175, 373 (1968)
Erratum: Nuclear Magnetic Resonance and Relaxation of $^{197}$Au in Gold Metal and $^{109}$Ag in Gold–Silver Alloys—Albert Narath. [163, 232 (1967)] 175, 696 (1968)
Erratum: Nuclear Magnetic Resonance and Relaxation in Iridium Metal: The Nuclear Magnetic Dipole Moments of $^{191}$Ir and $^{193}$Ir—Albert Narath. [165, 506 (1968)] 175, 696 (1968)
Nuclear Magnetic Resonance in the Metal $ReO_3$: $^{185}$Re and $^{187}$Re Knight Shifts and Spin Relaxation Rates—Albert Narath and D. C. Barham. 176, 479 (1968)
NARAYAN, D. S.
Relation between the Damping of Large Transverse Momenta in Elastic and Inelastic Collisions from Unitarity—D. S. Narayan. 176, 2154 (1968)
NARAYANASWAMY, P.
Current Algebra and Photoproduction of Pions—M. S. Bhatia and P. Narayanaswamy. 172, 1742 (1968)
Accurate Solution of a Bethe-Salpeter Equation for a Fermion-Antifermion System Bound via Vector Exchange—P. Narayanaswamy and Antonio Pagnamenta. 172, 1750 (1968)
Erratum: Current Algebra and Photoproduction of Pions—M. S. Bhatia and P. Narayanaswamy. [172, 1742 (1968)] 176, 2167 (1968)
NARDELLI, G. F.
Vibrational Structures Accompanying the Optic Transitions of Bound Electrons in Crystals—E. Mulazzi, G. F. Nardelli, and N. Terzi. 172, 847 (1968)
NARDUCCI, Lorenzo
Quantum-Mechanical Description of Two Coupled Harmonic Oscillators—Lee E. Estes, Thomas H. Keil, and Lorenzo M. Narducci. 175, 286 (1968)
NATH, L. M.
$O(3,1)$ Symmetry and Conspiracy in Photoproduction of Pions at High Energy—L. M. Nath. 174, 1942 (1968)
NATH, P.
Hard-Pion Current-Algebra Calculation of Meson Processes—Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 1999 (1968)
Application of Hard-Pion Three-Point Functions—R. Arnowitt, M. H. Friedman, and P. Nath. 174, 2008 (1968)
Hard-Pion Current-Algebra Calculation of Meson Processes—$N$-Point Functions—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1802 (1968)
Application of Hard-Pion Four-Point Functions to Pion-Pion Scattering—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1820 (1968)
NATH, R.
Pion Production, Current Algebra, and Coupling-Constant Relations—A. N. Mitra and R. Nath. 171, 1798 (1968)
NATHANS, R.
Phonon Spectrum of hcp $He^4$—V. J. Minkiewicz, T. A. Kitchens, F. P. Lipschultz, R. Nathans, and G. Shirane. 174, 267 (1968)
NAUMANN, R. A.
Decay of $Ho^{163}$—P. K. Hopke, J. S. Evans, and R. A. Naumann. 171, 1290 (1968)
Levels in Even-Even $Hg^{192}$, $Hg^{194}$, $Hg^{196}$, and $Hg^{198}$—R. F. Petry, R. A. Naumann, and J. S. Evans. 174, 1441 (1968)
NAVARRO, Q. O.
Neutron Diffraction by Liquid Zinc—B. A. Dasannacharya, Q. O. Navarro, H. Ibarra, S. Chatraphorn, and G. B. Lee. 173, 241 (1968)
NEDDERMEYER, Seth H.
Scattering of High-Energy Positive and Negative Muons on Electrons—Thomas B. W. Kirk and Seth H. Neddermeyer. 171, 1412 (1968)
NEE, T. W.
Surface Quantum States and Impedance Oscillations in a Weak Magnetic Field—Numerical Aspects—T. W. Nee, J. F. Koch, and R. E. Prange. 174, 758 (1968)
NE'EMAN, Y.
Large-Angle Scattering and the Fifth Interaction—Y. Ne'eman. 172, 1818 (1968)
NEES, Wilbur L.
Lattice-Dynamical Properties of $Fe^{57}$ Impurity Atoms in Pt, Pd, and Cu from Precision Measurements of Mössbauer Fractions—Rudi H. Nussbaum, Donald G. Howard, Wilbur L. Nees, and Charles F. Steen. 173, 653 (1968)
NEFKENS, B. M. K.
Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)
NEIGHBOURS, J. R.
Ultrasonic Attenuation near the Critical Point of $MnF_2$—J. R. Neighbours and R. W. Moss. 173, 542 (1968)
Ultrasonic Determination of the Pressure Dependence of the Superconducting Energy Gap in Tin—A. G. Beattie, J. E. Schirber, and J. R. Neighbours. 175, 599 (1968)
NELSON, T. J.
Phase-Space Distributions for the $4\pi$ Decay Mode of Isosinglet Bosons—T. J. Nelson. 172, 1701 (1968)
NELSON, William H.
Matrix Perturbations of the ESR of Trapped H, N, P, and As Atoms at 4.2°K—George S. Jackel, William H. Nelson, and Walter Gordy. 176, 453 (1968)
NEMBACH, Eckhard
Superconducting Transition Temperatures of Lead-Thallium Alloys—Eckhard Nembach. 172, 425 (1968)
NEMETH, J.
Relative Proton Number in Neutron Star Matter—J. Nemeth and Donald W. L. Sprung. 176, 1496 (1968)

NESBET, R. K.
Atomic Bethe-Goldstone Equations. III. Correlation Energies of Ground States of Be, B, C, N, O, F, and Ne—R. K. Nesbet. 175, 2 (1968)
Analysis of the Harris Variational Method in Scattering Theory—R. K. Nesbet. 175, 134 (1968)
NESTOR, C. W., Jr.
Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions—Thomas C. Tucker, Louis D. Roberts, C. W. Nestor, Jr., Thomas A. Carlson, and F. B. Malik. 174, 118 (1968)
NEWCOMB, C. P.
Ultrasonic Attenuation in Superconducting Mercury and Mercury-Cadmium Single Crystals—C. P. Newcomb and R. W. Shaw. 173, 509 (1968)
NEWMAN, E.
Study of Levels in $^{22}$Ne, $^{26}$Mg, and $^{34}$S by Proton Pickup—B. H. Wildenthal and E. Newman. 175, 1431 (1968)
NEWMAN, Ezra T.
Static, Axially Symmetric Point Horizons—Jeffrey Winicour, Allen I. Janis, and Ezra T. Newman. 176, 1507 (1968)
NEWSON, H. W.
High-Resolution Study of Isobaric Analog Resonances in $^{23}$Na—G. A. Keyworth, P. Wilhjelm, G. C. Kyker, Jr., H. W. Newson, and E. G. Bilpuch. 176, 1302 (1968)
NEWTON, D.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)
NEYNABER, R. H.
Erratum: Study of $H_2^+ + H_2 \to H_3^+ + H$ Using Merging Beams—R. H. Neynaber and S. M. Trujillo. [167, 63 (1968)] 171, 282 (1968)
NG, Anne
Gamma Rays from the Decay of $^{75}$Ge and $^{77}$Ge—Anne Ng, R. E. Wood, J. M. Palms, P. Venugopala Rao, and R. W. Fink. 176, 1329 (1968)
NICOLETTA, P. J.
Erratum: Ionization Loss at Relativistic Velocities—C. A. Nicoletta, P. J. McNulty, and P. L. Jain. [164, 1693 (1967)] 176, 2167 (1968)
NIEH, H. T.
Determination of Cabibbo Parameters from Baryon Decays—H. T. Nieh and Michael Martin Nieto. 172, 1694 (1968)
NIETO, Michael Martin
Determination of Cabibbo Parameters from Baryon Decays—H. T. Nieh and Michael Martin Nieto. 172, 1694 (1968)
NIGAVEKAR, Arun S.
Experimental Evidence for the Parratt X-Ray Excitation Theory—Staffan Bergwall and Arun S. Nigavekar. 175, 33 (1968)
NILSSON, P.-O.
Optical Properties of Epitaxial PbSe Films—C.-E. Blomqvist and P.-O. Nilsson. 174, 849 (1968)
NINHAM, Barry W.
Determination of Critical Behavior in Lattice Statistics from Series Expansions. I.—Anthony J. Guttmann, Barry W. Ninham, and Colin J. Thompson. 172, 554 (1968)
Asymptotic Behavior of the Pair Distribution Function of a Classical Electron Gas—D. J. Mitchell and B. W. Ninham. 174, 280 (1968)
NISHI, Masatsugu
Single-Quantum Annihilation of Positrons—Hiromasa Mazaki, Masatsugu Nishi, and Sakae Shimizu. 171, 408 (1968)
NOBLE, J. V.
Influence of Breakup Channels in Elastic Scattering of Composite Particles—P. M. Fishbane and J. V. Noble. 171, 1150 (1968)
Isotopic-Spin Mixing in Direct and Compound-Nuclear Reactions—J. V. Noble. 173, 1034 (1968)
NOGAMI, Y.
Superconvergence Relations and Possible New Resonances in Pion-Baryon Scattering—D. Kiang, W. C. Lin, R. Sugano, H. E. Lin, and Y. Nogami. 176, 2159 (1968)
NÖLDEKE, G. K.
Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)
NOLT, I. G.
Far-Infrared Properties of Lattice Resonant Modes. II. Stress Effects—I. G. Nolt and A. J. Sievers. 174, 1004 (1968)
NORBERG, R. E.
Diffusion Coefficients and Nuclear Magnetic Susceptibility of Dilute $He^3$–He II Solutions—J. E. Opfer, K. Luszczynski, and R. E. Norberg. 172, 192 (1968)
NORDBERG, M. E., Jr.
Pion Double-Charge-Exchange Cross-Section Measurements—C. J. Cook, M. E. Nordberg, Jr., and R. L. Burman. 174, 1374 (1968)
NORDTVEDT, K., Jr.
Low-Temperature Effects of the Tunneling Integral in Hydrogen-Bonded Ferroelectrics—K. Nordtvedt, Jr. 173, 547 (1968)
NORTHCLIFFE, L. C.
Equilibrium Charge States of Br and I Ions in Solids and Gases in the Energy Range 10–180 MeV—C. D. Moak, H. O. Lutz, L. B. Bridwell, L. C. Northcliffe, and S. Datz. 176, 427 (1968)
Proton-Proton Bremsstrahlung at 47 MeV—D. L. Mason, M. L. Halbert, and L. C. Northcliffe. 176, 1159 (1968)
NORTON, R. E.
Current Commutators and Electromagnetic Mass Differences—John M. Cornwall and R. E. Norton. 173, 1637 (1968)
NOWIK, Israel
Molecular-Field Theory for Randomly Substituted Ferrimagnetic Garnet Systems—Israel Nowik. 171, 550 (1968)
NOWLIN, C. H.
Magnetic Properties of $Ga_{2-x}Fe_xO_3$—B. F. Levine, C. H. Nowlin, and R. V. Jones. 174, 571 (1968)
NURMIA, Matti J.
Analysis of Excitation Functions in Cm(C,$xn$)No Reactions—Torbjorn Sikkeland, Albert Ghiorso, and Matti J. Nurmia. 172, 1232 (1968)
NUSIMOVICI, M.
Raman Scattering in $KNO_3$ Phases I, II, and III—M. Balkanski, M. K. Teng, and M. Nusimovici. 176, 1098 (1968)

NUSSBAUM, Rudi H.
Lattice-Dynamical Properties of $Fe^{57}$ Impurity Atoms in Pt, Pd, and Cu from Precision Measurements of Mössbauer Fractions—Rudi H. Nussbaum, Donald G. Howard, Wilbur L. Nees, and Charles F. Steen. 173, 653 (1968)
NUSSINOV, Shmuel
Diffractive $2\pi$ Production and $\pi$-$\pi$ Interactions—S. Nussinov. 172, 1446 (1968)
Current-Current Interaction and Calculation of the Nonleptonic Baryon Decays—Shmuel Nussinov and Giuliano Preparata. 175, 2180 (1968)
NUTTAL, J.
Extension of the Contour-Distortion Method in Relativistic Three-Particle Scattering—G. D. McCartor and J. Nuttall. 171, 1627 (1968)
NUYTS, J.
Simultaneous "Partial-Wave" Expansion in the Mandelstam Variables: Crossing Symmetry for Partial Waves—A. P. Balachandran and J. Nuyts. 172, 1821 (1968)
Simultaneous Partial-Wave Expansion in the Mandelstam Variables: The Group $SU(3)$—A. P. Balachandran, W. J. Meggs, J. Nuyts, and P. Ramond. 176, 1700 (1968)
OADES, G. C.
Theoretical Study of $K_{l4}$ Decay—F. A. Berends, A. Donnachie, and G. C. Oades. 171, 1457 (1968)
OAKES, R. J.
Behavior of Current Divergences under $SU_3 \times SU_3$—Murray Gell-Mann, R. J. Oakes, and B. Renner. 175, 2195 (1968)
OBENSHAIN, Felix E.
Coulomb-Recoil-Implantation Mössbauer Experiments with $^{73}Ge$—Gordon Czjzek, J. L. C. Ford, Jr., John C. Love, Felix E. Obenshain, and Horst H. F. Wegener. 174, 331 (1968)
O'CONNELL, R. F.
Effect of the Anomalous Magnetic Moment of the Electron on the Nonlinear Lagrangian of the Electromagnetic Field—R. F. O'Connell. 176, 1433 (1968)
OGATA, H.
Elastic and Inelastic Proton Scattering from Even Isotopes of Cd, Sn, and Te—W. Makofske, W. Savin, H. Ogata, and T. H. Kruse. 174, 1429 (1968)
OHLSEN, Gerald G.
Search for the Ground State of $^5H$ by means of the $^3H(t,p)$ Reaction—P. G. Young, Richard H. Stokes, and Gerald G. Ohlsen. 173, 949 (1968)
Search for States in the Three-Neutron and Triton Systems—Gerald G. Ohlsen, Richard H. Stokes, and P. G. Young. 176, 1163 (1968)
OHLSEN, W. D.
Defects in Rutile. I. Electron Paramagnetic Resonance of Interstitially Doped $n$-Type Rutile—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1091 (1968)
Defects in Rutile. II. Diffusion of Interstitial Ions—Paul I. Kingsbury, Jr., W. D. Ohlsen, and O. W. Johnson. 175, 1099 (1968)
Defects in Rutile. III. Optical and Electrical Properties of Impurities and Charge Carriers—O. W. Johnson, W. D. Ohlsen, and Paul I. Kingsbury, Jr. 175, 1102 (1968)
OHNUMA, H.
Experimental Study of the $(d,He^3)$ Reaction on Even-$A$ Isotopes of Mo—H. Ohnuma and J. L. Yntema. 176, 1416 (1968)
O'KANE, D. F.
Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)
OLDHAM, William J. B., Jr.
Excitation of the $n^1S$ States of Helium by Proton Impact—William J. B. Oldham, Jr. 174, 145 (1968)
OLESEN, P.
Covariant Version of the Bjorken Limit—P. Olesen. 172, 1461 (1968)
Asymptotic Behavior of the $n$-Point Function and Some Applications—P. Olesen. 175, 2165 (1968)
OLIVE, D. I.
Properties of Mandelstam Cuts—D. I. Olive and J. C. Polkinghorne. 171, 1475 (1968)
OLNESS, J. W.
$E2$ and $M1$ Matrix Elements in $B^{10}$—E. K. Warburton, J. W. Olness, S. D. Bloom, and A. R. Poletti. 171, 1178 (1968)
Nuclear Structure of $Na^{22}$. V. Doppler-Shift Attenuation Measurements—P. Paul, J. W. Olness, and E. K. Warburton. 173, 1063 (1968)
OLSEN, David K.
Search for Unbound States in $He^3$ through $Li^6(p,\alpha)$—David K. Olsen and Ronald E. Brown. 176, 1192 (1968)
OLSEN, Haakon A.
Polarization Effects in Induced Emission of Bremsstrahlung—Hans Kolbenstvedt and Haakon A. Olsen. 175, 11 (1968)
Exact Calculation of Pair Production—Ingjald Øverbø, Kjell J. Mork, and Haakon A. Olsen. 175, 1978 (1968)
OLSEN, S.
Proton-Neutron Triple Scattering at 425 MeV. I.—S. C. Wright, D. Shawhan, L. Pondrom, S. Olsen, and R. Handler. 175, 1704 (1968)
OLSSON, M. G.
Superconvergence and Regge Poles. I. Odd-Signature Exchanges—M. G. Olsson. 171, 1681 (1968)
O'MALLEY, F. O.
Angular Dependence of Scattering Products in Electron-Molecule Resonant Excitation and in Dissociative Attachment—Thomas F. O Malley and Howard S. Taylor. 176, 207 (1968)
OMAR, M. A.
Plasma Frequency as a Test of Intervalley Transfer in the Gunn Effect—M. A. Omar. 171, 925 (1968)
OMIDVAR, K.
Electron-Impact Ionization of H (2s) and H (2p)—H. Lee Kyle and K. Omidvar. 176, 164 (1968)
ONEDA, S.
Sum Rules from Charge-Charge-Density and Charge-Charge Commutators—S. Matsuda and S. Oneda. 171, 1743 (1968)
Derivation of Intermultiplet Mass Formulas from the Chiral $SU(3) \otimes SU(3)$ Charge Algebra—S. Matsuda and S. Oneda. 174, 1992 (1968)
Sum Rules Involving the $\rho$ and $A_1$ Mesons and the $A_1 \to \rho + \pi$ Decay—S. Matsuda and S. Oneda. 174, 2106 (1968)
O'NEILL, G. K.
Charge-Exchange Scattering of $K^+$ Mesons from Beryllium at 0.97 BeV/$c$—J. Gezelter, G. L. Salmon, F. V. Murphy, G. K. O'Neill, and R. Grismore. 173, 1315 (1968)
ONG, Kwok Maw
Inelastic Effects in $P_{11}$-State $\pi N$ Scattering—Kwok Maw Ong. 174, 1977 (1968)
ÔNO, K.
Quadrupolar Hyperfine Anisotropy in $Fe(NH_4SO)_2 \cdot 6H_2O$ and Its Comparison with the Magnetic Susceptibility—R. Ingalls, K. Ôno, and Louis Chandler. 172, 295 (1968)
OPFER, J. E.
Diffusion Coefficients and Nuclear Magnetic Susceptibility of Dilute $He^3$–He II Solutions—J. E. Opfer, K. Luszczynski, and R. E. Norberg. 172, 192 (1968)

OPIE, A. H.
**A Quantum Dissipation Theory of Anharmonic Crystals**—A. H. Opie. 172, 640 (1968)
O'RAIFEARTAIGH, L.
**Coupling of the Spacelike and Timelike Wave Functions at Infinite Momentum**—Shau-Jin Chang and L. O'Raifeartaigh. 171, 1587 (1968)
**A Mass-Splitting Theorem for General Definitions of Mass**—A. Böhm and L. O'Raifeartaigh. 171, 1698 (1968)
ORBACH, R.
Zero-Field Splitting of *S*-State Ions. III. Corrections to Parts I and II and Application to Distorted Cubic Crystals—R. R. Sharma, T. P. Das, and R. Orbach. 171, 378 (1968)
OSBORN, Hugh
**Relativistic Center-of-Mass Variables for Two-Particle Systems with Spin**—Hugh Osborn. 176, 1514 (1968)
Relativistic Corrections to Nonrelativistic Two-Particle Dynamical Calculations: Demonstration of the Validity of the Drell-Hern-Gerasimov Sum Rule for Weakly Bound Composite Particles—Hugh Osborn. 176, 1523 (1968)
OSBORN, R. W.
Search for Cosmic Gamma Radiation in the Southern Sky—J. G. Duthie and R. W. Osborn. 176, 1505 (1968)
OSBORNE, L. S.
Wide-Angle Electron-Positron Pair Production. K. J. Cohen, S. Homma, D. Luckey, and L. S. Osborne. 173, 1339 (1968)
OSTER, Ludwig
Inverse Compton Effect and Universal 3°K Radiation—Ludwig Oster. 176, 1501 (1968)
ØSTGAARD, E
Liquid $^3$He. II. Three-Body Correlations and their Contribution to the Binding Energy—E. Østgaard. 171, 248 (1968)
Liquid $^3$He. III. The Binding Energy and Other Properties at Zero Temperature—E. Østgaard. 176, 351 (1968)
OUDET, J.
**Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/*c***—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)
**Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/*c***—A. Fridman, G. Maurer, A. Michalon, J. Oudet, R. Straub, C. Voltolini, and P. Cüer. 176, 1595 (1968)
ØVERBØ, Ingjald
Exact Calculation of Pair Production—Ingjald Øverbø, Kjell J. Mork, and Haakon A. Olsen. 175, 1978 (1968)
OVERHAUSER, A. W.
Magnetoresistance of Potassium—John R. Reitz and A. W. Overhauser. 171, 749 (1968)
OVERLEY, J. C.
Nonexistence of the 14.6-MeV State in $Be^7$—P. D. Parker, D. W. Mingay, and J. C. Overley. 176, 1211 (1968)
OZIER, Irving
Nuclear Radio-Frequency Spectra of a Series of Tetrahedral Molecules—Irving Ozier, Lawrence M. Crapo, and Sang Soo Lee. 172, 63 (1968)
PADDOCK, R. A.
Scattering of 24.5-MeV Protons from $^{89}$Y—W. Benenson, S. M. Austin, R. A. Paddock, and W. G. Love. 176, 1268 (1968)
PADOVANI, F. A.
**Influence of Ellipsoidal Energy Surfaces on the Differential Resistance of Schottky Barriers**—R. Stratton and F. A. Padovani. 175, 1072 (1968)
PAGELS, Heinz
Electromagnetic Mass Differences and Regge Phenomenology—David J. Gross and Heinz Pagels. 172, 1381 (1968)
Broken *SU*(3) Symmetry, Sum Rules, and the Magnetic Moments of the Baryons—T. P. Cheng and Heinz Pagels. 172, 1635 (1968)
PAGNAMENTA, Antonio
Accurate Solution of a Bethe-Salpeter Equation for a Fermion-Antifermion System Bound via Vector Exchange—P. Narayanaswamy and Antonio Pagnamenta. 172, 1750 (1968)
**Model for Pion *S*-Wave Phase Shifts from Current Algebra and Partial Conservation of Axial-Vector Current**—A. M. S. Amatya, A. Pagnamenta, and B. Renner. 172, 1755 (1968)
($K\pi$) Phase Shifts from a Current-Algebra Model—Antonio Pagnamenta and B. Renner. 172, 1761 (1968)
Multiple Scattering in the Quark Model—David R. Harrington and Antonio Pagnamenta. 173, 1599 (1968)
PAHOR, S.
Multiple Scattering and the Inverse Albedo Problem—S. Pahor. 175, 218 (1968)
PAI, D. M.
Photogeneration of Carriers in Vitreous Selenium—D. M. Pai and S. W. Ing, Jr. 173, 729 (1968)
PAIS, A.
Some Remarks about Dynamical Asymmetry—A. Pais. 173, 1587 (1968)
Study of the Decays $K \to l\bar{l}$ and $K \to \pi l\bar{l}$—A. Pais and S. B. Treiman. 176, 1974 (1968)
PAKVASA, S.
Pole Models for *S*-Wave Hyperon Decay—D. S. Carlstone, S. P. Rosen, and S. Pakvasa. 174, 1877 (1968)
PÁL, L.
Magnetic Structures and Exchange Interactions in the Mn–Pt System—E. Krén, G. Kádár, L. Pál, J. Sólyom, P. Szabó, and T. Tarnóczi. 171, 574 (1968)
PALEV, C. D.
Lorentz-Pole Model and Polarization in High-Energy Charge-Exchange Pion-Nucleon Scattering—N. G. Antoniou, S. R. Komy, C. D. Palev, and M. Samiullah. 175, 1757 (1968)
PALMER, W. F.
Bootstrap Calculation of Vector-Meson–Baryon Coupling Constants—G. L. Kane and W. F. Palmer. 172, 1648 (1968)
PALMS, J. M.
Gamma Rays from the Decay of $^{73}$Ge and $^{71}$Ge—Anne Ng, R. E. Wood, J. M. Palms, P. Venugopala Rao, and R. W. Fink. 176, 1329 (1968)
PALUMBO, G.
Measurements of the Stark Broadening of Two Neutral Helium Lines in a Plasma—J. R. Greig, C. P. Lim, G. A. Moo-Young, G. Palumbo, and Hans R. Griem. 172, 148 (1968)
PAPON, P.
Unitary Theory of Dynamic Polarization of Nuclear Spins in Liquids and Solids—P. Papon, J. L. Motchane, and J. Korringa. 175, 641 (1968)
PARANJAPE, V. V.
Acoustoelectric Effect in Polar Semiconductors—V. V. Paranjape and S. B. Joshi. 174, 919 (1968)
PARDEE, W. J.
Currents as Coordinates in Nonrelativistic Quantum Mechanics—W. J. Pardee, L. Schlessinger, and Jon Wright. 175, 2140 (1968)
PARIKH, J. C.
Structure of the Self-Consistent Solutions for Even-Even Nuclei in the $2p$-$1f$ Shell—J. C. Parikh and J. P. Svenne. 174, 1343 (1968)

Investigation of Ground-State Correlations for a Model Hamiltonian of the Nucleus—J. C. Parikh and D. J. Rowe. 175, 1293 (1968)

PARK, J. C.
Spin-Parity Analysis of the Low-Mass (1.1–1.4 BeV) $K^{*}\pi$ System in $K^{-}p \rightarrow \bar{K}^{*0}\pi^{-}p$ at 5.5 BeV/$c$—J. C. Park and S. Kim. 174, 2165 (1968)

PARKER, A. W.
$^{16}O(\alpha,2\alpha)^{12}C_{g.s.}$ Reaction Mechanisms near 25 MeV—A. W. Parker, J. S. Allen, R. L. Yerke, and V. G. Stotland. 174, 1093 (1968)

PARKER, E. H. C.
Self-Diffusion in Solid Argon—E. H. C. Parker, H. R. Glyde, and B. L. Smith. 176, 1107 (1968)

PARKER, James H., Jr.
Phonon Dispersion Curves by Raman Scattering in SiC, Polytypes 3C, 4H, 6H, 15R, and 21R—D. W. Feldman, James H. Parker, Jr., W. J. Choyke, and Lyle Patrick. 173, 787 (1968)

PARKER, L.
Equivalence Principle and Motion of a Gyroscope—L. Parker. 175, 1658 (1968)

PARKER, P. D.
$N^{14}(\alpha,\gamma)F^{18}$ Reaction—P. D. Parker. 173, 1021 (1968)
Nonexistence of the 14.6-MeV State in $Be^{7}$—P. D. Parker, D. W. Mingay, and J. C. Overley. 176, 1211 (1968)

PARKINSON, E. M.
Properties of the Lithium Sequence—A. Dalgarno and E. M. Parkinson. 176, 73 (1968)

PARKINSON, Michael
Final-State Interactions in the $K \rightarrow 3\pi$ and $\eta \rightarrow 3\pi$ Decays—Michael Parkinson. 172, 1607 (1968)

PARKS, R. D.
Fluxoid Quantization and Field-Induced Depairing in a Hollow Superconducting Microcylinder—R. P. Groff and R. D. Parks. 176, 567 (1968)

PARKS, S. I.
$I^{127}$ Nuclear Quadrupole Resonance in Antiferromagnetic $UI_3$—S. I. Parks and W. G. Moulton. 173, 333 (1968)

PARSONS, G.
Erratum: Precise Theory of the Zeeman Spectrum for Atomic Hydrogen and Deuterium and the Lamb Shift—Stanley J. Brodsky and Ronald G. Parsons. [163, 134 (1967)] 176, 423 (1968)

PASCHOS, Emmanuel A.
Regge Poles for Spinless Particles in the Backward Direction—Emmanuel A. Paschos. 171, 1620 (1968)

PASSELL, L.
Phase Separation in $He^{3}$-$He^{4}$ Mixtures Observed with Slow Neutrons—R. I. Schermer, L. Passell, and D. C. Rorer. 173, 277 (1968)

PASTINE, D. John
Simplified Theory of Anharmonic Contributions to the Thermodynamic Properties of Solid Sodium Metal—D. John Pastine. 175, 905 (1968)

PATI, J. C.
Once-Subtracted Dispersion Relations, Current Algebra, and $Kl_3$ Form Factors—J. C. Pati and K. J. Sebastian. 174, 2033 (1968)

PATIL, Sharashchandra H.
Two Simple Approximation Schemes for Lippmann-Schwinger-Type Equations—L. A. P. Balázs and Sharashchandra H. Patil. 171, 1633 (1968)
Scalar- and Tensor-Tadpole Contribution to $K^{0}$-$K^{+}$ Mass Difference—Sharashchandra H. Patil. 172, 1528 (1968)

PATNAIK, P. K.
Pion Production in the Proton-Deuteron Interaction—P. K. Patnaik. 175, 2069 (1968)

PATRICK, Lyle
Higher Absorption Edges in 6H SiC—W. J. Choyke and Lyle Patrick. 172, 769 (1968)
Phonon Dispersion Curves by Raman Scattering in SiC, Polytypes 3C, 4H, 6H, 15R, and 21R—D. W. Feldman, James H. Parker, Jr., W. J. Choyke, and Lyle Patrick. 173, 787 (1968)

PATRONIS, E. T., Jr.
Directional Correlations in the Decay of $^{146}Pm$—L. D. Wyly, E. T. Patronis, Jr., and C. H. Braden. 172, 1153 (1968)

PATTEN, Frank W.
Paramagnetic $NH_3Cl$ and $NH_3Br$ Color Centers in Irradiated Ammonium Halide Single Crystals—Frank W. Patten. 175, 1216 (1968)

PAUL, P.
Magnetic Dipole Transitions and Isospin in $Be^{8}$—P. Paul, D. Kohler, and K. A. Snover. 173, 919 (1968)
Nuclear Structure of $Na^{22}$. V. Doppler-Shift Attenuation Measurements—P. Paul, J. W. Olness, and E. K. Warburton. 173, 1063 (1968)
Lifetimes of Levels in $A=10$ Nuclei—T. R. Fisher, S. S. Hanna, D. C. Healey, and P. Paul. 176, 1130 (1968)
Lifetimes of Levels in $^{11}C$, $^{13}C$, and $^{13}N$—F. Riess, P. Paul, J. B. Thomas, and S. S. Hanna. 176, 1140 (1968)

PAUL, William
Conduction-Band Structure of GaSb from Pressure Experiments to 50 kbar—B. B. Kosicki, A. Jayaraman, and William Paul. 172, 764 (1968)
Tuning of PbSe Lasers by Hydrostatic Pressure from 8 to 22 $\mu$—J. M. Besson, William Paul, and A. R. Calawa. 173, 699 (1968)

PAYNE, G. L.
Intermediate Structure and Particle-Hole States in Nuclear Reactions—G. L. Payne. 174, 1227 (1968)

PAYTON, Daniel N., III
Dynamics of Disordered Harmonic Lattices. III. Normal-Mode Spectra for Abnormal Arrays—Daniel N. Payton, III, and William M. Visscher. 175, 1201 (1968)

PEACHER, Jerry L.
Critical Assessment of the Polarized-Orbital Method in Atomic Scattering—Marvin H. Mittleman and Jerry L. Peacher. 173, 160 (1968)
Rotational Excitation of Polar Molecules by Electrons—M. H. Mittleman and J. L. Peacher and B. F. Rozsnyai. 176, 180 (1968)

PEARSON, J. M.
Nuclear-Matter Criterion for Semirealistic Hartree-Fock Interactions—J. M. Pearson and Gerard Saunier. 173, 991 (1968)

PEART, R. F.
Isotope Effect for Diffusion of Iron in Vanadium—M. G. Coleman, C. A. Wert, and R. F. Peart. 175, 788 (1968)

PEASLEE, D. C.
$(d,p)$ Spectroscopic Factors from the Butler-Born Approximation—D. C. Peaslee. 171, 1208 (1968)

PEAT, F. David
Antisymmetrization of Geminal Wave Functions. III. Calculations of the Density Matrix and Energy of a Three-Electron Atom—F. David Peat. 173, 69 (1968)
Application of Geminal Methods to Molecular Calculations—C. F. Bender, E. R. Davidson, and F. D. Peat. 174, 75 (1968)

PECCEI, R. D.
Chiral Lagrangian Calculation of Pion-Nucleon Scattering Lengths—R. D. Peccei. 176, 1812 (1968)

PEEBLES, P. J. E.
Comment on the Anisotropy of the Primeval Fireball—P. J. E. Peebles and David T. Wilkinson. 174, 2168 (1968)
PEERCY, P. S.
Study of the Radio-Frequency Size Effect in Potassium—P. S. Peercy, W. M. Walsh, Jr., L. W. Rupp, Jr., and P. H. Schmidt. 171, 713 (1968)
PEGG, D. J.
Radiative Mean-Life Measurements of Some Atomic-Hydrogen Excited States Using Beam-Foil Excitation—E. L. Chupp, L. W. Dotchin, and D. J. Pegg. 175, 44 (1968)
PEIERLS, R. F.
Shielding of Crystal Fields at Rare-Earth Ions—R. M. Sternheimer, M. Blume, and R. F. Peierls. 173, 376 (1968)
PENCZER, Rudolf E.
Energy Dependence of Damage Recovery in n-Type Ge Electron-Irradiated at 4.2°K—Rudolf E. Penczer and Henry M. DeAngelis. 171, 862 (1968)
PENNEY, R.
Axially Symmetric Zero-Mass Meson Solutions of Einstein Equations—R. Penney. 174, 1578 (1968)
PENZ, P. A.
Strain-Dependent Magnetoresistance of Potassium—P. A. Penz and R. Bowers. 172, 991 (1968)
Fermi Surface of Potassium as Measured by Helicon Doppler-Shifted Cyclotron Resonance—P. A. Penz and Toshinoto Kushida. 176, 804 (1968)
PERCUS, J. K.
Time Evolution of the Total Distribution Function of a One-Dimensional System of Hard Rods—J. L. Lebowitz, J. K. Percus, and J. Sykes. 171, 224 (1968)
PERES, Asher
Canonical Quantization of Gravitational Field—Asher Peres. 171, 1335 (1968)
PERESSINI, P. P.
Study of an Impurity Mode Using Specific-Heat Measurements—J. P. Harrison, P. P. Peressini, and R. O. Pohl. 171, 1037 (1968)
PERETTI, J.
Theory of Localized Vibrations of Interstitial Atoms in bcc Lattices—G. Blaesser, J. Peretti, and G. Toth. 171, 665 (1968)
PEREY, C. M.
11-MeV Proton Optical-Model Analysis—C. M. Perey, F. G. Perey, J. K. Dickens, and R. J. Silva. 175, 1460 (1968)
PEREY, F. G.
11-MeV Proton Optical-Model Analysis—C. M. Perey, F. G. Perey, J. K. Dickens, and R. J. Silva. 175, 1460 (1968)
PEREZ-MENDEZ, Victor
Double Charge Exchange of Positive $\pi$ Mesons on Complex Nuclei—P. E. Boynton, Thomas J. Devlin, J. Solomon, and V. Perez-Mendez. 174, 1083 (1968)
$\pi^-$-$^4$He Inelastic and Capture Reactions Leading to Excited and Multineutron Final States—Leon Kaufman, Victor Perez-Mendez, and John Sperinde. 175, 1358 (1968)
PEREZ-Y-JORBA, J.
Positive Pion Photoproduction from Hydrogen for Incident Photon Energies 300–750 MeV—C. Betourne, J. C. Bizot, J. Perez-Y-Jorba, D. Treille, and W. Schmidt. 172, 1343 (1968)
PERKINS, J. F.
Coupled-States Method for Scattering Calculations—J. F. Perkins. 173, 164 (1968)
PERKINS, R. B.
Test of Time-Reversal Invariance via a $\beta$-$\gamma$-$\gamma$ Angular Correlation in $^{106}$Rh-$^{106}$Pd—R. B. Perkins and E. T. Ritter. 174, 1426 (1968)
PERL, M. L.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)
Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)
PERLOW, Gilbert J.
Influence of Radio-Frequency Magnetic Fields on the Mössbauer Effect in Magnetic $Co^{57}$ Sources—Gilbert J. Perlow. 172, 319 (1968)
PERRIN, Robert
Spectral Representations for Symmetry-Breaking Parameters—Robert Perrin. 172, 1675 (1968)
PERSSON, B.
Nuclear Properties and Magnetic Hyperfine Interaction of $Os^{189}$—B. Persson, H. Blumberg, and M. Bent. 174, 1509 (1968)
PESTIEAU, J.
Determination of the Electromagnetic Couplings of the $\rho$ and $A_1$ Mesons—P. De Baenst and J. Pestieau. 171, 1805 (1968)
PETERS, P. B.
Recovery of Resistivity of Pure and Alloyed Aluminum in Stages II and III after 2-MeV Electron Irradiation—P. B. Peters and P. E. Shearin. 174, 691 (1968)
PETERS, R. E.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)
PETERSON, M. A.
Distribution of Blackbody Cavity Radiation in a Moving Frame of Reference—G. R. Henry, R. B. Feduniak, J. E. Silver, and M. A. Peterson. 176, 1451 (1968)
PETERSON, R. J.
Inelastic Scattering of 42-MeV Alpha Particles from $K^{39}$ and $V^{51}$—R. J. Peterson. 172, 1098 (1968)
PETERSON, Robert L.
Short-Range Magnetic Order in a Modified Weiss Molecular-Field Theory—Robert L. Peterson. 171, 586 (1968)
PETRY, R. F.
Levels in Even-Even $Hg^{192}$, $Hg^{194}$, $Hg^{196}$, and $Hg^{198}$—R. F. Petry, R. A. Naumann, and J. S. Evans. 174, 1441 (1968)
PETTIT, G. D.
Band Gap of Gallium Phosphide from 0 to 900°K and Light Emission from Diodes at High Temperatures—M. R. Lorenz, G. D. Pettit, and R. C. Taylor. 171, 876 (1968)
PEVERLEY, J. Roger
Magnetoacoustic Effect in Potassium—J. Roger Peverley. 173, 689 (1968)
PHELPS, A. V.
Self-Broadening of Cesium Resonance Lines at 8521 and 8944 Å—C. L. Chen and A. V. Phelps. 173, 62 (1968)
PHILLIPS, J. C.
Form Factors of Truncated Atomic Potentials—J. C. Phillips and R. Sandrock. 174, 663 (1968)
PHILLIPS, Walter C.
X-Ray Determination of Electron Momenta in Li, Be, B, Na, Mg, Al, and LiF—Walter C. Phillips and R. J. Weiss. 171, 790 (1968)

X-Ray Determination of the Electron Momentum Density in Diamond, Graphite, and Carbon Black—Richard J. Weiss and Walter C. Phillips. 176, 900 (1968)

PICCIONI, O.
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)

PICCIOTTO, Charles
$\rho^0$ Photoproduction and $\pi^0$ Production via $\rho^0$ Regge-Trajectory Exchange—Charles Picciotto. 171, 1648 (1968)
Radiative Correction to Pion Photoproduction—Charles Picciotto and Allan S. Krass. 174, 2109 (1968)

PICCIRELLI, Robert A.
Theory of the Dynamics of Simple Fluids for Large Spatial Gradients and Long Memory—Robert A. Piccirelli. 175, 77 (1968)

PIERCE, T. E.
Stopping Powers of $S^{32}$, $Cl^{35}$, $Br^{79}$, and $I^{127}$ Ions in Mylar—T. E. Pierce, W. W. Bowman, and Marshall Blann. 172, 287 (1968)
Stopping Powers and Ranges of 5–90-MeV $S^{32}$, $Cl^{35}$, $Br^{79}$, and $I^{127}$ Ions in $H_2$, He, $N_2$, Ar, and Kr: A Semiempirical Stopping Power Theory for Heavy Ions in Gases and Solids—T. E. Pierce and Marshall Blann. 173, 390 (1968)

PIGNOTTI, A.
Multiperipheral Bootstrap Model—G. F. Chew and A. Pignotti. 176, 2112 (1968)

PINAJIAN, J. J.
Evidence for a 0+ State in $^{62}$Zn Populated by $^{62}$Ga—H. K. Carter, J. H. Hamilton, A. V. Ramayya, and J. J. Pinajian. 174, 1329 (1968)

PINKAU, K.
Experimental Tests of Cascade Theory at High Energies—R. Holynski, W. V. Jones, and K. Pinkau. 176, 1661 (1968)

PINSKY, Stephen
Large-Angle Proton-Proton Scattering and the Pomeranchuk Trajectory—Kerson Huang and Stephen Pinsky. 174, 1915 (1968)

PIPKIN, F. M.
Pressure Shifts of Hyperfine Splitting of Hydrogen and Tritium in Argon—R. A. Brown and F. M. Pipkin. 174, 48 (1968)

PIRIE, J. D.
Lattice Dynamics and Ionic Deformation in Some Alkali Halides—J. S. Melvin, J. D. Pirie, and T. Smith. 175, 1082 (1968)

PISTORIUS, Carl W. F. T.
Phase Diagrams of the Cuprous Halides to High Pressures—Eliezer Rapoport and Carl W. F. T. Pistorius. 172, 838 (1968)
Effect of Pressure on the Polymorphism and Melting Points of the Thallous Halides—Carl W. F. T. Pistorius and J. B. Clark. 173, 692 (1968)

PLATZKER, A.
Antiferromagnetic Domains in $RbMnF_3$—W. J. Ince and A. Platzker. 175, 650 (1968)

PLATZMAN, P. M.
Fermi-Liquid Effects on High-Frequency Wave Propagation in Simple Metals—P. M. Platzman, W. M. Walsh, Jr., and E-Ni Foo. 172, 689 (1968)
Light Scattering from a Plasma in a Magnetic Field—P. M. Platzman, P. A. Wolff, and N. Tzoar. 174, 489 (1968)
Sum Rule for the Landau Fermi-Liquid Parameters in Metals—W. F. Brinkman, P. M. Platzman, and T. M. Rice. 174, 495 (1968)

PLEASONTON, Frances
Fission-Fragment Energy-Correlation Measurements for the Thermal-Neutron Fission of $^{233}$U—Frances Pleasonton. 174, 1500 (1968)

PODINI, P.
Data and Speculations on the Electronic Problem for the Relaxed Excited *F* Center—L. Bosi, P. Podini, and G. Spinolo. 175, 1133 (1968)

POHL, R. O.
Study of an Impurity Mode Using Specific-Heat Measurements—J. P. Harrison, P. P. Peressini, and R. O. Pohl. 171, 1037 (1968)

POIRIER, J. A.
Compilation of $\pi^- p$ Data at 4 GeV/*c*: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

POLETTI, A. R.
*E*2 and *M*1 Matrix Elements in $B^{10}$—E. K. Warburton, J. W. Olness, S. D. Bloom, and A. R. Poletti. 171, 1178 (1968)

POLICHAR, R. M.
Semidirect *T*-Forbidden Reaction $^{12}C(d, \alpha)^{10}B_0^*$, $T = 1$—J. Jänecke, T. F. Yang, R. M. Polichar, and W. S. Gray. 175, 1301 (1968)

POLKINGHORNE, J. C.
Properties of Mandelstam Cuts—D. I. Olive and J. C. Polkinghorne. 171, 1475 (1968)

POLLACK, S. A.
Optical Spectrum and Zeeman Effect of $CaF_2$:$Eu^{2+}$—P. Kisliuk, H. H. Tippins, C. A. Moore, and S. A. Pollack. 171, 336 (1968)

POLLAK, Fred H.
Piezo-Electroreflectance in Ge, GaAs, and Si—Fred H. Pollak and Manuel Cardona. 172, 816 (1968)

POLLAK, M.
Piezoresistance and Piezo-Hall Effects in *n*-ZnSe—A. Sagar, M. Pollak, and W. Lehmann. 174, 859 (1968)

PONDROM, L.
Proton-Neutron Triple Scattering at 425 MeV. I.—S. C. Wright, D. Shawhan, L. Pondrom, S. Olsen, and R. Handler. 175, 1704 (1968)

PONZINI, R.
$SU(6)_W$ and High-Energy Photoproduction—S. Meshkov and R. Ponzini. 175, 2030 (1968)

POORE, R. V.
Spins of Levels in $^{33}$P—C. E. Moss, R. V. Poore, N. R. Roberson, and D. R. Tilley. 174, 1333 (1968)

PORILE, N. T.
Angular-Distribution Study of the $Cu^{65}(He^3, x\pi)$ Reaction Products—I. Fujiwara and N. T. Porile. 173, 1055 (1968)
Differential Range Study of $(\alpha, x\pi)$ Reactions of Copper—N. T. Porile and I. Fujiwara. 176, 1166 (1968)

PORTERFIELD, C. D.
Reaction $T(^3He,\gamma)^6Li$ in the Energy Range 0.5-11 MeV—S. L. Blatt, A. M. Young, S. C. Ling, K. J. Moon, and C. D. Porterfield. 176, 1147 (1968)

PORTO, S. P. S.
Optical Phonons of Yttrium Aluminum Garnet—J. P. Hurrell, S. P. S. Porto, I. F. Chang, S. S. Mitra, and R. P. Bauman. 173, 851 (1968)
Raman Spectrum of Single-Domain $BaTiO_3$—M. DiDomenico, Jr., S. H. Wemple, S. P. S. Porto, and R. P. Bauman. 174, 522 (1968)

POSKANZER, A. M.
Fission of $U^{238}$ by 2.2-GeV Protons—V. P. Crespo, J. B. Cumming, and A. M. Poskanzer. 174, 1455 (1968)
POSSIN, George E.
Complex Radio-Frequency Impedance of Type-II Superconductors—George E. Possin and Kenneth W. Shepard. 171, 458 (1968)
POSTMUS, C.
Pressure Dependence of Infrared Eigenfrequencies of KCl and KBr—C. Postmus, J. R. Ferraro, and S. S. Mitra. 174, 983 (1968)
POWELL, B. E.
Measurement of Higher-Order Elastic Constants, Using Finite Deformations—B. E. Powell and M. J. Skove. 174, 977 (1968)
POWELL, B. M.
Lattice Dynamics of Niobium-Molybdenum Alloys—B. M. Powell, P. Martel, and A. D. B. Woods. 171, 727 (1968)
POWELL, C. J.
Characteristic Energy Losses of 8-keV Electrons in Liquid Al, Bi, In, Ga, Hg, and Au—C. J. Powell. 175, 972 (1968)
POWELL, Richard C.
Energy Transfer between Chromium Ions in Nonequivalent Sites in $Li_2Ge_7O_{15}$—Richard C. Powell. 173, 358 (1968)
POWERS, D.
Range and $dE/dx$ of C, N, O, F, and Ne in Be and C from 500 keV to 2 MeV—W. K. Chu, P. D. Bourland, K. H. Wang, and D. Powers. 175, 342 (1968)
PRADHAN, T.
Conductivity of a Plasma in a Steady Magnetic Field. II—T. Pradhan and B. Dasgupta. 176, 309 (1968)
PRANGE, R. E.
Three Geometrical Modifications of the Surface-Impedance Experiment in Low Magnetic Fields—R. E. Prange. 171, 737 (1968)
Surface Quantum States and Impedance Oscillations in a Weak Magnetic Field—Numerical Aspects—T. W. Nee, J. F. Koch, and R. E. Prange. 174, 758 (1968)
PREDAZZI, E.
Elastic Unitarity and Phase Equality of Scattering Amplitudes—A. Giovannini, E. Predazzi, and F. Selleri. 173, 1660 (1968)
PREISS, I. L.
Deformation in the Light Ba Isotopes: Isomeric States of $Ba^{125}$ and $Ba^{127}$—J. M. D'Auria, H. Bakhru, and I. L. Preiss. 172, 1176 (1968)
PREPARATA, Giuliano
Ultraviolet Divergences in Radiative Corrections to Weak Decays—Giuliano Preparata and William I. Weisberger 175, 1965 (1968)
Current-Current Interaction and Calculation of the Nonleptonic Baryon Decays—Shmuel Nussinov and Giuliano Preparata. 175, 2180 (1968)
PRESTWICH, W. V.
Study of the $Nb^{93}(\pi_{res},\gamma)Nb^{94}$ Reaction—W. V. Prestwich, R. E. Coté, and Hla Shwe. 174, 1421 (1968)
PRICE, Richard E.
Measurements of $L_2$- and $L_3$-Subshell Fluorescence Yields in Heavy Elements—Richard E. Price, Hans Mark, and C. D. Swift. 176, 3 (1968)
PRIMACK, Joel R.
Electromagnetic Interactions of Loosely-Bound Composite Systems—Stanley J. Brodsky and Joel R. Primack. 174, 2071 (1968)
PRIMAK, William
Effect of Ion Bombardment on the Electrical Conductivity of Germanium—William Primak and Yogeshwar Dayal. 175, 1033 (1968)
PROSTAK, Arnold
Electromodulation of the Optical Properties of Gold—Wilford N. Hansen and Arnold Prostak. 174, 500 (1968)
PU, Robert T.
Many-Body Approach to the Atomic Hyperfine Problem. I. Lithium-Atom Ground State—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 1 (1968)
Many-Body Calculation of Atomic Polarizability—Relation to Hartree-Fock Theory—Edward S. Chang, Robert T. Pu, and T. P. Das. 174, 16 (1968)
PUFF, R. D.
Liquid Structure Factor of Ground-State $He^4$—N. Mihara and R. D. Puff. 174, 221 (1968)
PUGH, H. G.
$Be^9(p,p\alpha)He^5$ Reaction at 57 MeV—P. G. Roos, H. G. Pugh, Mahavir Jain, H. D. Holmgren, Martin Epstein, and C. A. Ludemann. 176, 1246 (1968)
PUMPLIN, Jon
Elastic Scattering from Deuterium—Jon Pumplin. 173, 1651 (1968)
PURSEY, D. L.
Wave Equations on a Hyperplane—C. L. Hammer, S. C. McDonald, and D. L. Pursey. 171, 1349 (1968)
PYLE, G. J.
Nuclear-Matter Radii from a Reformulated Optical Model—G. W. Greenlees, G. J. Pyle, and Y. C. Tang. 171, 1115 (1968)
PYTTE, E.
Critical Behavior of the Pseudospin Model of Order–Disorder Type Ferroelectrics—E. Pytte and H. Thomas. 175, 610 (1968)
QUEISSER, H. J.
Electron-Phonon Coupling in the Barriers of GaAs Schottky Diodes—P. Thomas and H. J. Queisser. 175, 983 (1968)
QUINN, H. R.
Renormalization of Weak Form Factors, and the Cabibbo Angle—H. R. Quinn and J. D. Bjorken. 171, 1660 (1968)
QUINN, J. J.
Fermi-Liquid Effects on Plasma Wave Propagation in Metals—S. C. Ying and J. J. Quinn. 173, 473 (1968)
QUIRK, T. W.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)
RABII, Sohrab
Erratum: Investigation of Energy-Band Structures and Electronic Properties of PbS and PbSe—Sohrab Rabii. [167, 801 (1968)] 171, 1114 (1968)
Erratum: Investigation of Energy-Band Structures and Electronic Properties of PbS and PbSe—Sohrab Rabii. [167, 801 (1968)] 173, 918 (1968)
RABL, Arnulf
Cancellation of Divergences in Reggeized Electromagnetic Mass Differences—Arnulf Rabl. 176, 2034 (1968)

RADESCU, Eugen E.
Pion-Nucleon Spin-Flip Current-Algebra Sum Rule—Eugen E. Radescu. 171, 1655 (1968)
RADHAKRISHNA, S.
Optical, Electrical, and EPR Studies of KBr Crystals Doped with Cadmium—S. C. Jain and S. Radhakrishna. 172, 972 (1968)
RADO, George T.
Theory of Anisotropic Spontaneous Magnetization and Anisotropy Energy in Orthorhombic Ferromagnets at 0°K—George T. Rado. 176, 644 (1968)
RADOSEVICH, Lee G.
Experimental and Theoretical Study of the Scattering of Phonons by $U$ Centers in Alkali Halide Crystals—Lee G. Radosevich and Charles T. Walker. 171, 1004 (1968)
RAFANELLI, Kenneth
Intrinsic Invariance Groups, Mass Operators, and Linear Wave Equations—Kenneth Rafanelli. 175, 1761 (1968)
Spherical Kemmer Top—Kenneth Rafanelli. 175, 1947 (1968)
RAHM, D. C.
Two-Prong Interaction by $\pi^+ + p$ Collisions at 2.77 BeV/$c$—S. S. Yamamoto and D. C. Rahm. 173, 1302 (1968)
RAHMAN, Aneesur
Inelastic Scattering of Neutrons by Polycrystals—F. W. de Wette and Aneesur Rahman. 176, 784 (1968)
RAISBECK, G. M.
Light Nuclei Emitted in the Fission of $^{252}$Cf—G. M. Raisbeck and T. D. Thomas. 172, 1272 (1968)
RAMAN, K.
Unitarity Corrections to Pole Dominance in Spectral-Function Sum Rules—W. S. Lam and K. Raman. 173, 1497 (1968)
Continuous-Moment Sum Rules and Pion Conspiracy in Photoproduction—K. Raman and Kashyap V. Vasavada. 175, 2191 (1968)
RAMASWAMY, M. K.
K-x-Ray–$\gamma$-Ray Directional Correlation in the Decay of $Ba^{133}$—Michael McDonnell and M. K. Ramaswamy. 171, 1278 (1968)
RAMAYYA, A. V.
Evidence for a 0+ State in $^{68}$Zn Populated by $^{68}$Ga—H. K. Carter, J. H. Hamilton, A. V. Ramayya, and J. J. Pinajian. 174, 1329 (1968)
RAMDAS, A. K.
Raman Spectrum of Crystalline Benzil—S. A. Solin and A. K. Ramdas. 174, 1069 (1968)
RAMOND, P.
Eigenvectors for the Partial-Wave "Crossing Matrices"—A. P. Balachandran, W. J. Meggs, and P. Ramond. 175, 1974 (1968)
Simultaneous Partial-Wave Expansion in the Mandelstam Variables: The Group $SU(3)$—A. P. Balachandran, W. J. Meggs, J. Nuyts, and P. Ramond. 176, 1700 (1968)
RANGNEKAR, Sadanand S.
Laser-Induced Instabilities in Raman-Active Media—Keith A. Brueckner and Sadanand S. Rangnekar. 175, 332 (1968)
RANK, D. H.
Stimulated Thermal Rayleigh Scattering in Liquids—C. W. Cho, N. D. Foltz, D. H. Rank, and T. A. Wiggins. 175, 271 (1968)
RANK, David M.
Search for Stable Fractionally Charged Particles—David M. Rank. 176, 1635 (1968)
RAO, J. Subba
Second-Order Weak Processes and Weak-Interaction Cutoff—R. N. Mohapatra, J. Subba Rao, and R. E. Marshak. 171, 1502 (1968)
RAO, P. Venugopala
Gamma Rays from the Decay of $^{75}$Ge and $^{77}$Ge—Anne Ng, R. E. Wood, J. M. Palms, P. Venugopala Rao, and R. W. Fink. 176, 1329 (1968)
RAPOPORT, Eliezer
Phase Diagrams of the Cuprous Halides to High Pressures—Eliezer Rapoport and Carl W. F. T. Pistorius. 172, 838 (1968)
RAQUET, C. A.
Heat Capacity of $Mn(CH_3COO)_2 \cdot 4H_2O$ between 0.4 and 20°K—J. H. Schelleng, C. A. Raquet, and S. A. Friedberg. 176, 708 (1968)
RASHID, Harun-ar
Meson-Baryon and Baryon-Baryon Scattering in Reggeized $U(6) \otimes U(6)$ Theory—R. Delbourgo and Harun-ar Rashid. 176, 2074 (1968)
RASMUSSEN, V. K.
Gamma-Ray Widths of the 3.00-MeV Level of $Al^{27}$ and the 3.13-MeV Level of $P^{31}$—S. W. Robinson, C. P. Swann, and V. K. Rasmussen. 174, 1320 (1968)
RAST, H. E.
Infrared Dispersion and Lattice Vibrations of $LaF_3$—H. E. Rast, H. H. Caspers, S. A. Miller, and R. A. Buchanan. 171, 1051 (1968)
RAUBENHEIMER, L. J.
Note on the Scattering Cross Sections of the Isotopes of Dysprosium—H. R. Child, L. J. Raubenheimer, W. C. Koehler, and R. M. Moon. 174, 1553 (1968)
Magnetic Structures of $Er_2O_3$ and $Yb_2O_3$—R. M. Moon, W. C. Koehler, H. R. Child, and L. J. Raubenheimer. 176, 722 (1968)
RAVENHALL, D. G.
Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)
RAY, D. K.
Theoretical Study on the Anisotropy of the Spin-Lattice Relaxation for Paramagnetic Ions by MgO Crystal—Santosh Kumar, T. Ray, and D. K. Ray. 176, 489 (1968)
RAY, Supriya
Short-Range Effects on the Pressure Shift for a Nitrogen Atom in a Rare-Gas Atmosphere—Supriya Ray and T. P. Das. 174, 32 (1968)
Hyperfine Pressure Shift and van der Waals Interaction. I. Hydrogen-Helium System—Supriya Ray, J. D. Lyons, and T. P. Das. 174, 104 (1968)
Hyperfine Pressure Shift and van der Waals Interaction. II. Nitrogen-Helium System—J. D. Lyons, Supriya Ray, and T. P. Das. 174, 112 (1968)
RAY, T.
Theoretical Study on the Anisotropy of the Spin-Lattice Relaxation for Paramagnetic Ions by MgO Crystal—Santosh Kumar, T. Ray, and D. K. Ray. 176, 489 (1968)
RAYNE, J. A.
de Haas–van Alphen Effect in $n$-Type $Bi_2Te_3$—R. B. Mallinson, J. A. Rayne, and R. W. Ure, Jr. 175, 1049 (1968)
RAZAVY, M.
Hamiltonian Operator for Velocity-Dependent Potentials—M. Razavy. 171, 1201 (1968)
READING, J. F.
High-Energy Nonlocal Nucleon-Nucleus Optical Potential for a Central Two-Body Force with Second-Order Corrections to the Impulse Approximation—J. F. Reading and Alan D. MacKellar. 173, 1026 (1968)
REAMES, D. V.
Cosmic-Ray Propagation—C. E. Fichtel and D. V. Reames. 175, 1564 (1968)

REATTO, L.
On the Theory of Quantized Vortices—G. V. Chester, R. Metz, and L. Reatto. 175, 275 (1968)
REED, T. B.
Electrical Properties of $Ti_2O_3$ Single Crystals—J. M. Honig and T. B. Reed. 174, 1020 (1968)
REED, W. A.
High-Field Galvanomagnetic Properties of Niobium—W. A. Reed and R. R. Soden. 173, 677 (1968)
High-Field Galvanomagnetic Effects in Antiferromagnetic Chromium—A. J. Arko, J. A. Marcus, and W. A. Reed. 176, 671 (1968)
REEDER, D. D.
Regge-Pole Analysis of Charge-Exchange and Hypercharge-Exchange Reactions in Pseudoscalar-Meson–Baryon Scattering—D. D. Reeder and K. V. L. Sarma. 172, 1566 (1968)
REEDY, R. C.
Study of the Particles Emitted from $Br^{75}$ Compound Nuclei Formed in Two Ways: $C^{12} + Cu^{63}$ and $O^{16} + Co^{59}$—J. M. D'Auria, M. J. Fluss, G. Herzog, L. Kowalski, J. M. Miller, and R. C. Reedy. 174, 1409 (1968)
REHN, Victor
Electroreflectance Studies of InAs, GaAs, and (Ga,In)As Alloys—E. W. Williams and Victor Rehn. 172, 798 (1968)
REICHERT, W. L.
Identification of 5.3-sec $^{118}Ag$ as a Product of $^{235}U$ Fission—H. V. Weiss, J. M. Fresco, and W. L. Reichert. 172, 1266 (1968)
REIDY, J. J.
High-Resolution Gamma-Ray Spectroscopic Study of the Decay $^{133}Ba \rightarrow {}^{133}Cs$—D. P. Donnelly, J. J. Reidy, and M. L. Wiedenbeck. 173, 1192 (1968)
REIF, F.
Investigation of a New Kind of Energetic Neutral Excitation in Superfluid Helium—C. M. Surko and F. Reif. 175, 229 (1968)
REILLY, Edith F.
Erratum: Matrix Elements of the Spin-Spin Interaction for the $f^3$ Electron Configuration—Edith F. Reilly. [170, 1 (1968)] 174, 329 (1968)
REILLY, Michael H.
Ionic Transport in Potassium Chloride—Robert G. Fuller, Charles L. Marquardt, Michael H. Reilly, and John C. Wells, Jr. 176, 1036 (1968)
REINE, M.
Theory of Multiphoton Magnetoabsorption in Semiconductors—Margaret H. Weiler, M. Reine, and Benjamin Lax. 171, 949 (1968)
REITER, George F.
Magnon Density Fluctuations in the Heisenberg Ferromagnet—George F. Reiter. 175, 631 (1968)
REITZ, John R.
Magnetoresistance of Potassium—John R. Reitz and A. W. Overhauser. 171, 749 (1968)
REMLER, Edward A.
High-Energy Scattering by Nuclei—Edward A. Remler. 176 2108 (1968)
REMSBERG, L. P.
Angular Distributions of the Recoil Nuclei from the $Cu^{65}(p,p\pi)Cu^{64}$ Reactions at 0.37, 1.0, and 2.8 GeV—L. P. Remsberg. 174, 1338 (1968)
RENNER, B.
Model for Pion $S$-Wave Phase Shifts from Current Algebra and Partial Conservation of Axial-Vector Current—A. M. S. Amatya, A. Pagnamenta, and B. Renner. 172, 1755 (1968)
$(K\pi)$ Phase Shifts from a Current-Algebra Model—Antonio Pagnamenta and B. Renner. 172, 1761 (1968)
Behavior of Current Divergences under $SU_3 \times SU_3$—Murray Gell-Mann, R. J. Oakes, and B. Renner. 175, 2195 (1968)
RENSINK, Marvin E.
Modification of Friedel Oscillations by a Magnetic Field—Marvin E. Rensink. 174, 744 (1968)
RESNICK, L.
Quasidiffraction Scattering and Selection Rules for Spin and Parity—L. Resnick. 175, 2185 (1968)
RESNIKOFF, M.
Erratum: Symmetric Quark Model of Baryon Resonances—O. W. Greenberg and M. Resnikoff. [163, 1844 (1967)] 172, 1850 (1968)
REYNOLDS, B. G.
$\pi^- p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)
REYNOLDS, C. A.
Effect of Antimony, Indium, and Zinc Impurities on the Critical-Field Curve of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 543 (1968)
Anisotropy of the Residual Resistivity of Tin with Sb, In, Zn, and Cd Impurities, and the Ideal Resistivities and Deviations from Matthiessen's Rule at 77 and 273°K—F. V. Burckbuchler and C. A. Reynolds. 175, 550 (1968)
Calculation of the Effect of Superconducting Energy-Gap Anisotropy on the Thermal Conductivity of Tin—F. V. Burckbuchler, D. Markowitz, and C. A. Reynolds. 175, 556 (1968)
REYNOLDS, D. C.
Excited States of Bound Exciton Complexes in CdS—D. C. Reynolds, C. W. Litton, and T. C. Collins. 174, 845 (1968)
REYNOLDS, J. F.
Shear Stabilization of a Collision-Dominated Plasma—J. F. Reynolds and E. H. Holt. 175, 205 (1968)
REYNOLDS, J. T.
Coupled-Channel Calculation of $C^{12}$-Neutron Scattering—J. T. Reynolds, C. J. Slavik, C. R. Lubitz, and N. C. Francis. 176, 1213 (1968)
REYNOLDS, R. W.
Production of Divalent Thulium in CaO and $SrCl_2$—M. M. Abraham, R. W. Reynolds, and L. A. Boatner. 175, 485 (1968)
RHYNE, J. J.
Anomalous Hall Effect in Single-Crystal Dysprosium—J. J. Rhyne. 172, 523 (1968)
RIAZUDDIN
$A_1$-$\rho$-$\pi$ System and $\pi \rightarrow l\nu\gamma$ Decay—Riazuddin and Fayyazuddin. 171, 1428 (1968)
Spectral-Function Sum Rules and the Ratio $f_K/f_\pi$—Riazuddin and Fayyazuddin. 172, 1737 (1968)
$K_{l3}$ Form Factors in Current Algebra with Hard Pion and Kaon—Riazuddin and A. Q. Sarker. 173, 1752 (1968)
RICCI, F. P.
Mobility of Positive and Negative Charges in $^3He$ at the Critical Point—R. Cantelli, I. Modena, and F. P. Ricci. 171, 236 (1968)
RICE, Stuart A.
Unified Approximation for the Velocity Autocorrelation Function and the Structure Function of a Simple Liquid—Leon Glass and Stuart A. Rice. 176, 239 (1968)
Study of Exciton Dynamics in a Simple Liquid—Sighart Fischer and Stuart A. Rice. 176, 409 (1968)
RICE, T. M.
Sum Rule for the Landau Fermi-Liquid Parameters in Metals—W. F. Brinkman, P. M. Platzman, and T. M. Rice. 174, 495 (1968)

Landau Fermi-Liquid Parameters in Na and K—T. M. Rice. 175, 858 (1968)

RICHARD, Patrick

Two-Neutron-Hole Configurations in $Pb^{208}$ from Isobaric Analog Measurements—Patrick Richard, Nelson Stein, C. D. Kavaloski, and J. S. Lilley. 171, 1308 (1968)

Proton Decay of Analog States Formed in the $(d,n)$ Reaction—N. Cue and Patrick Richard. 173, 1108 (1968)

Determination of Total Widths and Resonance Energies of the Single-Particle Analog Resonances in $^{209}Bi$—W. R. Wharton, P. von Brentano, W. K. Dawson, and Patrick Richard. 176, 1424 (1968)

RICHARDS, Peter M.

Nuclear Spin-Wave Relaxation and Narrowing of NMR Lines in Ferro- and Antiferromagnets—Peter M. Richards. 173, 581 (1968)

RICKEY, F. A., Jr.

Characteristics of the Transition-State Spectra for $^{234}U$, $^{236}U$, and $^{240}Pu$ from $(d,pf)$ and $(t,pf)$ Angular-Correlation Experiments—H. C. Britt, F. A. Rickey, Jr., and W. S. Hall. 175, 1525 (1968)

RIDDLE, R. A. J.

Elastic Scattering of 14-MeV Neutrons by Deuterons—A. C. Berick, R. A. J. Riddle, and C. M. York. 174, 1105 (1968)

RIESS, F.

Lifetimes of Levels in $^{12}C$, $^{13}C$, and $^{12}N$—F. Riess, P. Paul, J. B. Thomas, and S. S. Hanna. 176, 1140 (1968)

RILEY, P. J.

Isobaric Analog Resonances in Proton Scattering from $^{124}Te$, $^{126}Te$, $^{128}Te$, and $^{130}Te$—J. L. Foster, Jr., P. J. Riley, and C. Fred Moore. 175, 1498 (1968)

$^{134}Xe(d,p)$ and $^{136}Xe(d,t)$ Reactions—P. A. Moore, P. J. Riley, C. M. Jones, M. D. Mancusi, and J. L. Foster, Jr. 175, 1516 (1968)

$^{31}P(d,\alpha)^{29}Si$ Reaction from 7.3 to 12.0 MeV—G. A. Lock, J. R. Curry, P. J. Riley, and C. G. Shugart. 176, 1293 (1968)

RIMINI, A.

Success and Limitations of Two- and Four-Quasiparticle Tamm-Dancoff Theories of Vibrational States: Applications to Even Tin Isotopes with a Realistic Nucleon-Nucleon Potential—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 173, 964 (1968)

Microscopic Theory of Effective Operators for Electromagnetic Interactions in Nuclei—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 175, 1243 (1968)

RISEBERG, L. A.

Multiphonon Orbit-Lattice Relaxation of Excited States of Rare-Earth Ions in Crystals—L. A. Riseberg and H. W. Moos. 174, 429 (1968)

Effective Density of Phonon States for $NdCl_3$ from Vibronic Spectra and Applications to Ion-Lattice Interactions—E. Cohen, L. A. Riseberg, and H. W. Moos. 175, 521 (1968)

RISTINEN, R. A.

Gamma Rays from the $Sc^{45}(p,p'\gamma)$ Reaction—C. Chasman, K. W. Jones, and R. A. Ristinen. 173, 1072 (1968)

RITCHIE, A. B.

Perturbation Theory for Exchange Interactions between Atoms and Molecules. I—A. B. Ritchie. 171, 125 (1968)

RITCHIE, R. H.

Radiative Decay of Coulomb-Stimulated Plasmons in Spheres—Julian Crowell and R. H. Ritchie. 172, 436 (1968)

Quantum Treatment of Multiple Real Transitions—J. C. Ashley and R. H. Ritchie. 174, 1572 (1968)

RITTER, E. T.

Test of Time-Reversal Invariance via a $\beta$-$\gamma$-$\gamma$ Angular Correlation in $^{106}Rh$-$^{106}Pd$—R. B. Perkins and E. T. Ritter. 174, 1426 (1968)

ROBERSON, N. R.

Spins of Levels in $^{33}P$—C. E. Moss, R. V. Poore, N. R. Roberson, and D. R. Tilley. 174, 1333 (1968)

ROBERTS, J. H.

Structure of the Fission Transition Nucleus $U^{236}$—A. N. Behkami, J. H. Roberts, W. Loveland, and J. R. Huizenga. 171, 1267 (1968)

Spontaneous-Fission Decay Constant of $^{238}U$—J. H. Roberts, Raymond Gold, and Roland J. Armani. 174, 1482 (1968)

ROBERTS, Louis D.

Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions—Thomas C. Tucker, Louis D. Roberts, C. W. Nestor, Jr., Thomas A. Carlson, and F. B. Malik. 174, 118 (1968)

ROBINSON, C. P.

Optical-Model Analysis of Alpha-Particle Scattering by $^{40}Ca$ from 12 to 18 MeV—C. P. Robinson, J. P. Aldridge, Joseph John, and R. H. Davis. 171, 1241 (1968)

ROBINSON, D. A.

Study of the $F^g$ Center in Several Alkali Halides—D. W. Lynch and D. A. Robinson. 174, 1050 (1968)

ROBINSON, D. K.

Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

ROBINSON, H. G.

Measurements of $g_J$ Ratios for $Rb^{85}$, $Rb^{87}$, Hydrogen, and Deuterium, and of the Hyperfine Separation of Deuterium—G. S. Hayne, E. S. Ensberg, and H. G. Robinson. 171, 20 (1968)

Determination of $g$-Factor Ratios for Free $Rb^{85}$ and $Rb^{87}$ Atoms—C. W. White, W. M. Hughes, G. S. Hayne, and H. G. Robinson. 174, 23 (1968)

ROBINSON, John E.

Electron-Phonon Interactions in Solid Alkali Metals. I. Scattering and Transport Coefficients—John E. Robinson and John D. Dow. 171, 815 (1968)

ROBINSON, S. W.

Gamma-Ray Widths of the 3.00-MeV Level of $Al^{27}$ and the 3.13-MeV Level of $P^{31}$—S. W. Robinson, C. P. Swann, and V. K. Rasmussen. 174, 1320 (1968)

ROBSON, D.

Neutron Spectroscopic Factors from Isobaric Analog States—W. J. Thompson, J. L. Adams, and D. Robson. 173, 975 (1968)

ROCHLEDER, E.

Soft-Core Hamada-Johnston Nucleon-Nucleon Potential—E. Rochleder and K. Erkelenz. 172, 1013 (1968)

ROGERS, E. H., Jr.

Spins and Nuclear Moments of $Sb^{115}$, $Sb^{117}$, $Sb^{118}$, $Sb^{119}$, and $Sb^{120}$—A. D. Jackson, Jr., E. H. Rogers, Jr., and G. J. Garrett. 175, 65 (1968)

ROGERS, R. N.

Magnetic Interactions between Rare-Earth Ions in Insulators. III. EPR Measurements of $Ce^{3+}$ Pair-Interaction Constants in $LaCl_3$—R. J. Birgeneau, M. T. Hutchings, and R. N. Rogers. 175, 1116 (1968)

ROGERS, Terence W.

Determination of Vacuum Regge Poles and Cuts—Terence W. Rogers and John H. Schwarz. 172, 1595 (1968)

ROHRER, H.
Antiferromagnetism and the Magnetic Phase Diagram of $GdAlO_3$—K. W. Blazey and H. Rohrer. 173, 574 (1968)
Magnetoresistance of Dilute Alloys—H. Rohrer. 174, 583 (1968)
ROMAN, P.
Static $SU(6)$ and Fundamental Substitution—Shin Ishida and P. Roman. 172, 1684 (1968)
RONAT, E. E.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)
ROOS, P. G.
$Be^9(p,p\alpha)He^5$ Reaction at 57 MeV—P. G. Roos, H. G. Pugh, Mahavir Jain, H. D. Holmgren, Martin Epstein, and C. A. Ludemann. 176, 1246 (1968)
ROPER, L. David
$K \to 2\pi$ Phenomenology with Small $CP$ Nonconservation—L. David Roper. 176, 2120 (1968)
RORER, D. C.
Phase Separation in $He^3$-$He^4$ Mixtures Observed with Slow Neutrons—R. I. Schermer, L. Passell, and D. C. Rorer. 173, 277 (1968)
ROS, P.
Theory of Transition-Metal Complexes: Unrestricted Hartree-Fock Molecular-Orbital Method and Its Application to $KNiF_3$—D. E. Ellis, A. J. Freeman, and P. Ros. 176, 688 (1968)
ROSE, P. H.
Measurement of One- and Two-Electron-Loss Cross Sections for $He^-$ Ions in $H_2$, He, and Ne Gases (400–1500 keV)—G. Ryding, A. B. Wittkower, and P. H. Rose. 174, 149 (1968)
ROSÉN, Arne
Relativistic Calculations of Electron Binding Energies by a Modified Hartree-Fock-Slater Method—Arne Rosén and Ingvar Lindgren. 176, 114 (1968)
ROSEN, Gerald
Dressed-Electron Stationary States in Quantum Electrodynamics—Gerald Rosen. 172, 1632 (1968)
Relativistic Particle-Antiparticle Stationary States in a Model Quantum Field Theory: Mesons from Quarks—Gerald Rosen. 173, 1680 (1968)
ROSEN, M.
Elastic Moduli and Ultrasonic Attenuation of Gadolinium, Terbium, Dysprosium, Holmium, and Erbium from 4.2 to 300°K—M. Rosen. 174, 504 (1968)
ROSEN, S. P.
Pole Models for $S$-Wave Hyperon Decay—D. S. Carlstone, S. P. Rosen, and S. Pakvasa. 174, 1877 (1968)
ROSENSTOCK, Herbert B.
Vibrations of Disordered Solids—Herbert B. Rosenstock and Richard E. McGill. 176, 1004 (1968)
ROSKIES, Ralph
Puzzle of Regge Dips—Ralph Roskies. 175, 1933 (1968)
ROSS, D. K.
High-Energy Multiple Scattering for Large Angles—D. K. Ross. 173, 1695 (1968)
ROSS, G. G.
Argand-Diagram Loops and Regge Poles—P. D. B. Collins, R. C. Johnson, and G. G. Ross. 176, 1952 (1968)
ROSS, Marvin
Shock Compression of Argon and Xenon. IV. Conversion of Xenon to a Metal-Like State—Marvin Ross. 171, 777 (1968)
ROST, E.
Pion-Nucleon Elastic Scattering above 1 GeV—E. Rost and L. Marshall Libby. 175, 1869 (1968)
ROTH, Laura M.
Magnetic Energy Levels in an Energy Band with Inversion Asymmetry Splitting—Laura M. Roth. 173, 755 (1968)
ROTH, Timothy
Study of $\pi N$ and $KN$ Elastic and Inelastic Scatterings and their Polarizations by a Multiple-Regge-Pole Model—Fei S. Chen-Cheung and Timothy Roth. 173, 1768 (1968)
ROTSSTEIN, Aaron
Calculation of the $P_{11}$ $\pi N$ Phase Shift Using Coupled $\pi N$, $\sigma N$, and $\epsilon N$ Channels—Ernestos N. Argyres and Aaron Rotstein. 174, 1689 (1968)
ROUSE, Carl A.
Erratum: Screened Coulomb Solutions of the Schrödinger Equation—Carl A. Rouse. [159, 41 (1967)] 176, 423 (1968)
Erratum: Finite Electronic Partition Function from Screened Coulomb Interactions—Carl A. Rouse. [163, 62 (1967)] 176, 423 (1968)
ROUTBORT, J. L.
Electromigration in Zinc Single Crystals—J. L. Routbort, 176, 796 (1968)
ROWE, D. J.
Methods for Calculating Ground-State Correlations of Vibrational Nuclei—D. J. Rowe. 175, 1283 (1968)
Investigation of Ground-State Correlations for a Model Hamiltonian of the Nucleus—J. C. Parikh and D. J. Rowe. 175, 1293 (1968)
ROWE, J. E.
New Evidence for the Existence of Exciton Effects at Hyperbolic Critical Points—Kerry L. Shaklee, J. E. Rowe, and Manuel Cardona. 174, 828 (1968)
ROWELL, J. M.
Excess Currents in Superconducting Tunnel Junctions—J. M. Rowell and W. L. Feldmann. 172, 393 (1968)
ROY, D. P.
Pion Conspiracy and Pion Residue from the Finite-Energy Photoproduction Sum Rule—D. P. Roy and Shu-Yuan Chu. 171, 1762 (1968)
ROY, Probir
Erratum: Generalized Pole-Dominance Hypothesis, Current Algebra, and $S$-Wave $K^*\rho$ Scattering—Probir Roy. [162, 1644 (1967)] 172, 1849 (1968)
Erratum: $K\pi$ Scattering, $\kappa$ Meson, and Current Algebra—Probir Roy. [168, 1708 (1968)] 172, 1850 (1968)
ROY, S. M.
$S$-Matrix Approach to Internal Symmetries. II—S. M. Roy. 173, 1671 (1968)
ROYER, J.
Effect of a Degenerate Neutrino Sea on Electromagnetism—J. Royer. 174, 1719 (1968)
ROZSNYAI, B. F.
Rotational Excitation of Polar Molecules by Electrons—M. H. Mittleman and J. L. Peacher and B. F. Rozsnyai. 176, 180 (1968)
RUBINSTEIN, H. R.
Bootstrap of Meson Trajectories from Superconvergence—M. Ademollo, H. R. Rubinstein, G. Veneziano, and M. A. Virasoro. 176, 1904 (1968)
Meson Bootstraps for Unnatural-Parity States—M. Bishari, H. R. Rubinstein, A. Schwimmer, and G. Veneziano. 176, 1926 (1968)
RUBINSTEIN, Mark
Hyperfine Field Spectra of Binary Fe-Co Alloys: Nuclear Magnetic Resonance of $^{57}Fe$ and $^{59}Co$—Mark Rubinstein. 172, 277 (1968)

RUBY, S. L.
Isomer Shift and Hyperfine Splittings of the 59.6-keV Mössbauer Resonance in $^{237}$Np—B. D. Dunlap, G. M. Kalvius, S. L. Ruby, M. B. Brodsky, and D. Cohen. 171, 316 (1968)
Mössbauer Measurements with $K^{40}$—P. K. Tseng, S. L. Ruby, and D. H. Vincent. 172, 249 (1968)
RUCH, J. G.
Transport Properties of GaAs—J. G. Ruch and G. S. Kino. 174, 921 (1968)
RUDERMAN, M.
Causes of Sound Faster than Light in Classical Models of Ultradense Matter—M. Ruderman. 172, 1286 (1968)
RUDNICK, I.
Measurement of the Density Maximum of $He^4$ at Saturated Vapor Pressure—M. Barmatz and I. Rudnick. 173, 275 (1968)
Superfluid Helmholtz Resonators—M. Kriss and I. Rudnick. 174, 326 (1968)
Superfluid Fraction of Liquid Helium Contained in Porous Vycor Glass—J. C. Fraser and I. Rudnick. 176, 421 (1968)
RUIJGROK, Th. W.
Absence of Magnetic Ordering in One and Two Dimensions in a Many-Band Model for Interacting Electrons in a Metal—M. B. Walker and Th. W. Ruijgrok. 171, 513 (1968)
RUPP, L. W., Jr.
Study of the Radio-Frequency Size Effect in Potassium—P. S. Peercy, W. M. Walsh, Jr., L. W. Rupp, Jr., and P. H. Schmidt. 171, 713 (1968)
RUSH, J. Edwin, Jr.
Parameters of Low-Energy $\Lambda$-$K^0$ Production—J. Edwin Rush, Jr. 173, 1776 (1968)
RUSHBROOKE, J. G.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)
RUVALDS, J.
Symmetry of the Wave Functions in the Band Theory of Ferromagnetic Metals—L. M. Falicov and J. Ruvalds. 172, 498 (1968)
de Haas–van Alphen Effect, Exchange Splitting, Spin-Orbit Interaction, and Magnetic Breakdown in Ferromagnetic Nickel—J. Ruvalds and L. M. Falicov. 172, 508 (1968)
RYDING, G.
Measurement of One- and Two-Electron-Loss Cross Sections for $He^-$ Ions in $H_2$, He, and Ne Gases (400–1500 keV)—G. Ryding, A. B. Wittkower, and P. H. Rose. 174, 149 (1968)
SAAM, W. F.
Phonon-Quasiparticle Interactions in Dilute Solutions of $He^3$ in Superfluid $He^4$. II. Phonon Boltzmann Equation and First Viscosity—Gordon Baym and W. F. Saam. 171, 172 (1968)
Phonon-Quasiparticle Interactions in Dilute Solutions of $He^3$ in Superfluid $He^4$: III. Attenuation of First Sound Above 0.2°K—Gordon Baym, W. F. Saam, and C. Ebner. 173, 306 (1968)
SACCHI, C. A.
Anti-Stokes Generation in Trapped Filaments of Light—C. A. Sacchi, C. H. Townes, and J. R. Lifsitz. 174, 439 (1968)
SAGAR, A.
Piezoresistance and Piezo-Hall Effects in $n$-ZnSe—A. Sagar, M. Pollak, and W. Lehmann. 174, 859 (1968)
SAHNI, R. J.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)
SAKITT, Barbara
Lewis-Oppenheimer-Wouthuysen Model Applied to Neutrino Reactions—Barbara Sakitt. 171, 1715 (1968)
SAKITT, M.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)
SALAM, Abdus
Reggeization of Quark Number—R. Delbourgo, Abdus Salam, and J. Strathdee. 172, 1727 (1968)
SALEEM, Mohammad
Critique of Empirical Mass Formula for Baryons—Mohammad Saleem. 176, 2166 (1968)
SALINGER, G. L.
Amplitude-Independent Longitudinal Ultrasonic Attenuation in Superconducting Lead—W. A. Fate, R. W. Shaw, and G. L. Salinger. 172, 413 (1968)
Ultrasonic Attenuation in the Superconducting State of High-Purity Thallium—H. J. Willard, Jr., R. W. Shaw, and G. L. Salinger. 175, 362 (1968)
SALMON, G. L.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Charge-Exchange Scattering of $K^+$ Mesons from Beryllium at 0.97 BeV/$c$—J. Gezelter, G. L. Salmon, F. V. Murphy, G. K. O'Neill, and R. Grismore. 173, 1315 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)
SAMARA, G. A.
Pressure and Temperature Dependence of the Dielectric Properties of Hydrogen-Bonded Ferroelectrics: $LiH_3(SeO_3)_2$ and $LiD_3(SeO_3)_2$—G. A. Samara. 173, 605 (1968)
SAMIULLAH, M.
Lorentz-Pole Model and Polarization in High-Energy Charge-Exchange Pion-Nucleon Scattering—N. G. Antoniou, S. R. Komy, C. D. Palev, and M. Samiullah. 175, 1757 (1968)
SAMPLE, J. T.
Energy Levels of $^{42}$Sc—W. J. McDonald, J. T. Sample, D. M. Sheppard, G. M. Stinson, and K. W. Jones. 171, 1254 (1968)
SAMSON, James A. R.
Photoelectron Spectroscopy of the Rare Gases—James A. R. Samson and R. B. Cairns. 173, 80 (1968)
SANDARS, P. G. H.
Electric Dipole Moments of Alkali Atoms. A Limit to the Electric Dipole Moment of the Free Electron—J. P. Carrico, E. Lipworth, P. G. H. Sandars, T. S. Stein, and M. C. Weisskopf. 174, 125 (1968)

SANDROCK, R.
Form Factors of Truncated Atomic Potentials—J. C. Phillips and R. Sandrock. 174, 663 (1968)
SANDWEISS, J.
Pion Production and Elastic Scattering in Antiproton-Proton Collisions at 6.94 BeV/$c$—T. Ferbel, J. A. Johnson, H. I. Kraybill, J. Sandweiss, and H. D. Taft. 173, 1307 (1968)
SARAVIA, Luis R.
High-Resolution Study of the One-Electron Spectrum of Si—Luis R. Saravia and David Brust. 171, 916 (1968)
Spin Splitting and the Ultraviolet Absorption of Ge—Luis R. Saravia and David Brust. 176, 915 (1968)
SARD, R. D.
Strange-Particle Production in 8-BeV/c Proton-Proton Interactions—M. Firebaugh, G. Ascoli, E. L. Goldwasser, R. D. Sard, and J. Wray. 172, 1354 (1968)
SARKER, A. Q.
Ratio of Axial-Vector to Vector Contributions in $K \to l\nu\gamma$ Decay—A. Q. Sarker. 173, 1749 (1968)
$K_{l3}$ Form Factors in Current Algebra with Hard Pion and Kaon—Riazuddin and A. Q. Sarker. 173, 1752 (1968)
$K_{l4}$ Form Factors in Current Algebra with Hard Pions and Kaon—A. Q. Sarker. 176, 1959 (1968)
Current Algebra and the Vector Form Factor in $K_{l4}$ Decays—A. Q. Sarker. 176, 1971 (1968)
SARMA, K. V. L.
Regge-Pole Analysis of Charge-Exchange and Hypercharge-Exchange Reactions in Pseudoscalar-Meson–Baryon Scattering—D. D. Reeder and K. V. L. Sarma. 172, 1566 (1968)
SARVER, C. E.
Photoconductivity Associated with Indium Acceptors in Silicon—J. S. Blakemore and C. E. Sarver. 173, 767 (1968)
SASLOW, W. M.
Surface Effects in the Heisenberg Antiferromagnet—D. L. Mills and W. M. Saslow. 171, 488 (1968)
Erratum: Surface Effects in the Heisenberg Antiferromagnet—D. L. Mills and W. M. Saslow. [171, 488 (1968)] 176, 760 (1968)
SASTRY, C. V.
Quark Model and Masses of Baryons and Mesons—S. P. Misra and C. V. Sastry. 172, 1402 (1968)
SATO, T.
Dynamic Polarization of Protons in Copper Tutton Salts (Dilute $CuK_4SO_4 \cdot 6H_2O$) and Their Spin-Lattice Relaxation Times—J. S. Karra, R. Clarkson, and T. Sato. 175, 479 (1968)
SATPATHY, L.
Projected Tamm-Dancoff Spectra of $Ne^{23}$ and $Mg^{24}$—L. Satpathy. 174, 1324 (1968)
SATPATHY, R. K.
Regge-Type Representations for Coulomb-Nuclear $S$ Matrix—C. S. Shastry and R. K. Satpathy. 175, 1544 (1968)
SATTEN, R. A.
Zeeman Splitting of Vibronic Levels for Octahedral Actinide and Lanthanide Complexes, Free and in Crystals—R. A. Satten, D. R. Johnston, and E. Y. Wong. 171, 370 (1968)
SATTLER, Allan R.
Partition of the Average Energy Deposited in Germanium as a Function of Incident Neutron Energy—Allan R. Sattler and Frederick L. Vook. 173, 435 (1968)
Channeling in Zinc-Blende Lattices: Energy-Loss Studies for Hydrogen and Helium Ions in InAs, GaSb, AlSb, and InSb—Allan R. Sattler and Frederick L. Vook. 175, 526 (1968)
SAUNIER, Gerard
Nuclear-Matter Criterion for Semirealistic Hartree-Fock Interactions—J. M. Pearson and Gerard Saunier. 173, 991 (1968)
SAUTER, G. D.
Neutron Scattering Cross Sections of $U^{233}$, $U^{235}$, and $Pu^{241}$ from 1 to 30 eV—G. D. Sauter and C. D. Bowman. 174, 1413 (1968)
SAVIN, W.
Elastic and Inelastic Proton Scattering from Even Isotopes of Cd, Sn, and Te—W. Makofske, W. Savin, H. Ogata, and T. H. Kruse. 174, 1429 (1968)
SAWADA, Tetsuo
Regge Behavior and the Cerulus-Martin Lower Bound of High-Energy Scattering—Tetsuo Sawada. 173, 1716 (1968)
SAWICKI, J.
Success and Limitations of Two- and Four-Quasiparticle Tamm-Dancoff Theories of Vibrational States: Applications to Even Tin Isotopes with a Realistic Nucleon-Nucleon Potential—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 173, 964 (1968)
One-Neutron Transfer Reactions in Even and Odd Tin Isotopes and a Realistic Nucleon-Nucleon Potential—R. Alzetta and J. Sawicki. 173, 1185 (1968)
Microscopic Theory of Effective Operators for Electromagnetic Interactions in Nuclei—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 175, 1243 (1968)
SAXENA, R. P.
Lorentz Poles and Bethe-Salpeter Equations: Does an Infinite Number of Lorentz Poles Exist?—N. P. Chang and R. P. Saxena. 176, 2101 (1968)
SCADRON, M. D.
Natural Zeros of Regge Residues—H. F. Jones and M. D. Scadron. 171, 1809 (1968)
Covariant $M$ Functions for Higher Spin—M. D. Scadron and H. F. Jones. 173, 1734 (1968)
SCALAPINO, D. J.
Dynamic Susceptibility of Magnetic Ions in Metals—Yung-Li Wang and D. J. Scalapino. 175, 734 (1968)
SCARBROUGH, J. O.
Specific Heat of Uranium Mononitride from 1.3 to 4.6°K—J. O. Scarbrough, H. L. Davis, W. Fulkerson, and J. O. Betterton, Jr. 176, 666 (1968)
SCARFONE, Leonard M.
Dispersion Methods in the 2$V$ Sector of the Lee Model—Leonard M. Scarfone. 174, 1903 (1968)
SCARL, D. B.
Measurements of Photon Correlations in Partially Coherent Light—D. B. Scarl. 175, 1661 (1968)
SCHAEFER, Henry F., III
Atomic Hyperfine Structure. I. Polarization Wave Functions for the Ground States of B, C, N, O, and F.—Henry F. Schaefer III, Richard A. Klemm, and Frank E. Harris. 176, 49 (1968)
SCHARENGUIVEL, J. H.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)
SCHARFSTEIN, H.
Some Aspects of Field Symmetries—H. Scharfstein. 172, 1828 (1968)
SCHEARER, L. D.
Spin Exchange between Optically Oriented Metastable Helium Atoms and Thermal Electrons in a Flowing Afterglow—L. D. Schearer. 171, 81 (1968)
Gyromagnetic Ratio of Helium $2^3S_1$ Atoms by Optical Pumping: Level Shifts—L. D. Schearer and F. D. Sinclair. 175, 36 (1968)
SCHECHTER, Joseph
Phenomenological Chiral Model for Nonleptonic Hyperon Decays—Joseph Schechter. 174, 1829 (1968)

SCHELLENG, J. H.
Heat Capacity of $Mn(CH_3COO)_2 \cdot 4H_2O$ between 0.4 and 20°K—J. H. Schelleng, C. A. Raquet, and S. A. Friedberg. 176, 708 (1968)
SCHENK, Ch.
Disappearance of a Vibrational Mode in the Ferroelectric Phase Transition of $KH_2PO_4$—Ch. Schenk, E. Wiener, B. Weckermann, and W. Kley. 172, 576 (1968)
SCHERMER, R. I.
Phase Separation in $He^3$-$He^4$ Mixtures Observed with Slow Neutrons—R. I. Schermer, L. Passell, and D. C. Rorer. 173, 277 (1968)
SCHICK, L. H.
$\Lambda$-$\Sigma$ Conversion and $\Lambda np$ Isospin-Zero Bound States—Alan J. Toepfer and L. H. Schick. 175, 1253 (1968)
SCHIFF, L. I.
High-Energy Scattering at Moderately Large Angles—L. I. Schiff. 176, 1390 (1968)
SCHILLACI, M. E.
Two-Body $K^-d$ Reactions as a Test of One-Meson Exchange—M. E. Schillaci and R. R. Silbar. 171, 1764 (1968)
SCHIRBER, J. E.
Ultrasonic Determination of the Pressure Dependence of the Superconducting Energy Gap in Tin—A. G. Beattie, J. E. Schirber, and J. R. Neighbours. 175, 599 (1968)
SCHLACHTER, A. S.
Charge-Exchange Collisions Between Helium Ions and Cesium Vapor in the Energy Range 1.5–25 keV—A. S. Schlachter, D. H. Loyd, P. J. Bjorkholm, L. W. Anderson, and W. Haeberli. 174, 201 (1968)
SCHLESINGER, M.
Investigations of $4f \leftrightarrow 5d$ Transitions of $Ce^{+3}$ in $CaF_2$—M. Schlesinger and P. W. Whippey. 171, 361 (1968)
SCHLESSINGER, L.
Calculation of Some Three-Body Scattering Amplitudes—L. Schlessinger. 171, 1523 (1968)
Currents as Coordinates in Nonrelativistic Quantum Mechanics—W. J. Pardee, L. Schlessinger, and Jon Wright. 175, 2140 (1968)
SCHMIDT, P.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)
SCHMIDT, P. H.
Study of the Radio-Frequency Size Effect in Potassium—P. S. Peercy, W. M. Walsh, Jr., L. W. Rupp, Jr., and P. H. Schmidt. 171, 713 (1968)
SCHMIDT, V. Hugo
Erratum: Dynamical Effects of Deuteron Intrabond Jumping in $KD_2PO_4$—V. Hugo Schmidt. [164, 749 (1967)] 173, 630 (1968)
SCHMIDT, W.
Positive Pion Photoproduction from Hydrogen for Incident Photon Energies 300–750 MeV—C. Betourne, J. C. Bizot, J. Perez-Y-Jorba, D. Treille, and W. Schmidt. 172, 1343 (1968)
Pion Photoproduction and Fixed-$t$ Dispersion Relations—J. Engels, A. Müllensiefen, and W. Schmidt. 175, 1951 (1968)
Determination of the Isotensor Electromagnetic Current from Pion Photoproduction—B. Gittelman and W. Schmidt. 175, 1998 (1968)
SCHMIEDER, Robert W.
Hyperfine Structure and Lifetimes of the $4^2P_{3/2}$ and $5^2P_{3/2}$ States of $K^{39}$—Robert W. Schmieder, Allen Lurio, and W. Happer. 173, 76 (1968)
SCHMITT, A.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)
SCHMITT, H. W.
Fission Energetics and Neutron Emission in 13-MeV Proton-Induced Fission of $^{226}Ra$—E. Konecny and H. W. Schmitt. 172, 1213 (1968)
Asymmetry, Anisotropy, and Excitation Function for the Proton-Induced Fission of $^{226}Ra$—E. Konecny and H. W. Schmitt. 172, 1226 (1968)
SCHNITZER, Howard J.
Structure of Three-Point Functions from $SU(3) \otimes SU(3)$ Algebra—Ira S. Gerstein, Howard J. Schnitzer, and Steven Weinberg. 175, 1873 (1968)
Chiral $SU(3) \otimes SU(3)$ Three-Point Function: Single-Particle Approximation—Ira S. Gerstein and Howard J. Schnitzer. 175, 1876 (1968)
SCHOEMAKER, Dirk
Spin Hamiltonian of Two Equivalent Nuclei: Application to the $I_2^-$ Centers—Dirk Schoemaker. 174, 1060 (1968)
SCHOLZ, W.
Level Spectra of Odd Isotopes of Ga, As, Br, and Rb in the Coriolis Coupling Model with a Residual Interaction of the Pairing Type—W. Scholz and F. B. Malik. 176, 1355 (1968)
SCHOONOVER, D. R.
Ion Energies at the Cathode for Conduction Through Rarefied Gases—D. R. Schoonover. 176, 331 (1968)
SCHRILS, R.
Measurements and Analyses of the $d_{5/2}$ Analog Resonance in the $^{88}Sr(p,n)^{88}Y$ Reaction—G. C. Dutt and R. Schrils. 175, 1413 (1968)
SCHROEDER, L. S.
$K^-p$ Elastic Scattering at 4.6 GeV/$c$—L. S. Schroeder, R. A. Leacock, R. L. Wagstaff, and W. J. Kernan. 176, 1648 (1968)
SCHUCAN, Thomas H.
Model-Independent Analysis of Inelastic Electron Scattering from Nuclei. I. Monopole and Quadrupole Excitations at Low Momentum Transfer—Thomas H. Schucan. 171, 1142 (1968)
SCHULMAN, Jerome M.
Perturbation-Theoretic Approach to Atoms and Molecules—Jeremy I. Musher and Jerome M. Schulman. 173, 93 (1968)
SCHULMAN, Lawrence
A Path Integral for Spin—Lawrence Schulman. 176, 1558 (1968)
SCHULT, O. W. B.
Nuclear Levels in $^{142}Pr$—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)
SCHULTZ, J.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)
SCHULTZ, S.
Transmission Electron Spin Resonance in Dilute Copper-Chromium Alloys—P. Monod and S. Schultz. 173, 645 (1968)
SCHUMACHER, M.
Lifetime of the 603-keV Level of $Te^{124}$—M. Schumacher. 171, 1279 (1968)
SCHUMACHER, R. T.
Knight Shift in Single-Crystal Mercury—R. W. Weinert and R. T. Schumacher. 172, 711 (1968)

SCHWARTZ, J. J.
Level Scheme and Configuration Mixing in $Sc^{44}$—J. J. Schwartz. 175, 1453 (1968)
SCHWARZ, John H.
Determination of Vacuum Regge Poles and Cuts—Terence W. Rogers and John H. Schwarz. 172, 1595 (1968)
Method of Pole Dominance and Applications—John H. Schwarz. 175, 1852 (1968)
SCHWEITZER, Donald G.
Hysteresis in Superconductors. III. Effect of Surface Energies on the Shielding and Field-Retaining Properties of Hollow Cylinders of Type-I Superconductors—Donald G. Schweitzer. 173, 461 (1968)
SCHWIMMER, A.
Meson Bootstraps for Unnatural-Parity States—M. Bishari, H. R. Rubinstein, A. Schwimmer, and G. Veneziano. 176, 1926 (1968)
SCHWINGER, Julian
Sources and Gravitons—Julian Schwinger. 173, 1264 (1968)
Sources and Magnetic Charge—Julian Schwinger. 173, 1536 (1968)
SCOTT, Allen B.
Photoconductivity in Colored Potassium Chloride—Frances H. Chapple, Gerhard Lehmann, and Allen B. Scott. 174, 1012 (1968)
SCOTT, Bruce L.
Off-Energy-Shell $t$-Matrix Elements for Local Potentials Containing Hard Cores—Robert Laughlin and Bruce L. Scott. 171, 1196 (1968)
SCOTT, David M.
$\kappa$-Meson Mass and Weak-Decay Parameters from a Study of $K_{l3}$ Form Factors—Jacob E. Mackey, J. Michael McKisic, David M. Scott, and Walter W. Wada. 172, 1590 (1968)
SCOTT, H. L.
Proton-Induced Reactions on $^{40}$Ar and Analogs of $^{41}$Ar Levels—H. L. Scott, W. Galati, J. L. Weil, and M. T. McEllistrem. 172, 1139 (1968)
SCOTTI, A.
Quark Interactions and Nucleon Form Factors—G. M. Cicuta, G. Marchesini, and A. Scotti. 175, 2113 (1968)
SCULLY, M.
Photon Echo in Gaseous Media—M. Scully, M. J. Stephen, and David C. Burnham. 171, 213 (1968)
SEBASTIAN, K. J.
Once-Subtracted Dispersion Relations, Current Algebra, and $K_{l3}$ Form Factors—J. C. Pati and K. J. Sebastian. 174, 2033 (1968)
SECHI-ZORN, B.
Final States with Two or More Strange Particles from 4.25-BeV/$c$ $K^-p$ Interactions—G. S. Abrams, R. G. Glasser, B. Kehoe, B. Sechi-Zorn, and G. Wolsky. 175, 1697 (1968)
Low-Energy $\Lambda$-Proton Elastic Scattering—B. Sechi-Zorn, B. Kehoe, J. Twitty, and R. A. Burnstein. 175, 1735 (1968)
SEGALL, B.
Phonon-Assisted Recombination of Free Excitons in Compound Semiconductors—B. Segall and G. D. Mahan. 171, 935 (1968)
SEGEL, R. E.
Gamma Decay of $T=\frac{3}{2}$ States in $Al^{25}$ and $P^{29}$—G. C. Morrison, D. H. Youngblood, R. C. Bearse, and R. E. Segel. 174, 1366 (1968)
SEGOVIA, N.
Calculation of the Magnetic Moment of Atomic Fluorine—V. Beltrán-López, E. Ley Koo, N. Segovia, and E. Blaisten. 172, 44 (1968)
SEGRÈ, G.
Models of Weak Interactions Mediated by Vector Bosons—G. Segrè. 173, 1730 (1968)
SEIDEL, G. S.
Steady-State, ac-Temperature Calorimetry—Paul F. Sullivan and G. Seidel. 173, 679 (1968)
Nuclear and Electron Resonance Study of the Paramagnetic Cobalt Ion—Sung Ho Choh and G. S. Seidel. 174, 385 (1968)
SELL, D. D.
Impurity-Induced Optical Fluorescence in $MnF_2$—R. L. Greene, D. D. Sell, R. S. Feigelson, G. F. Imbusch, and H. J. Guggenheim. 171, 600 (1968)
SELLERI, F.
Elastic Unitarity and Phase Equality of Scattering Amplitudes—A. Giovannini, E. Predazzi, and F. Selleri. 173, 1660 (1968)
SELOVE, W.
1-BeV Electron Compton Scattering near 180°—B. Gittelman, W. C. Barber, W. Selove, D. Tompkins, and F. Forman. 171, 1388 (1968)
SENFTLE, Frank E.
Van Vleck Paramagnetism in Orthorhombic $TiO_2$ (Brookite)—Frank E. Senftle and Arthur N. Thorpe. 175, 1144 (1968)
SENITZKY, I. R.
Quantum Optics. II. Description of a Mode—I. R. Senitzky. 174, 1588 (1968)
SERTORIO, L.
Regge Secondary Trajectories—G. C. Fox and L. Sertorio. 176, 1739 (1968)
SERWAY, R. A.
Electron-Spin-Resonance Absorption Spectrum of Trivalent Gadolinium in Single-Crystal Calcite—S. A. Marshall and R. A. Serway. 171, 345 (1968)
SETH, V. P.
Sum Rules for Meson-Baryon Scattering from Asymptotic Symmetry Requirements—V. P. Seth, B. K. Agarwal, and Y. M. Gupta. 173, 1759 (1968)
SHAFROTH, S. M.
Energy Levels in $^{89}$Y—P. F. Hinrichsen, S. M. Shafroth, and D. M. Van Patter. 172, 1134 (1968)
SHAH, Jagdeep
Electrical and Optical Enhancement of Photoconductivity in Semi-Insulating GaAs—Jagdeep Shah and Yizhak Yacoby. 174, 932 (1968)
Donor-Acceptor Pair Recombination Involving the First Excited State of a Donor in GaAs—Jagdeep Shah, R. C. C. Leite, and J. P. Gordon. 176, 938 (1968)
SHAKED, H.
Magnetic Structure of $NaNiF_3$—A. Epstein, J. Makovsky, M. Melamud, and H. Shaked. 174, 560 (1968)
SHAKIN, C. M.
Shell Model in the Continuum—Application to the Four-Nucleon System—Jörg Hüfner and C. M. Shakin. 175, 1350 (1968)
SHAKLEE, Kerry L.
New Evidence for the Existence of Exciton Effects at Hyperbolic Critical Points—Kerry L. Shaklee, J. E. Rowe, and Manuel Cardona. 174, 828 (1968)
SHANTA, R.
Analysis of Nuclear Scattering by Regge Poles—R. Shanta and C. S. Shastry. 176, 1254 (1968)
SHAPIRA, A.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)

Study of the Λ-*N* System in Low-Energy Λ-*p* Elastic Scattering—G. Alexander, U. Karshon, A. Shapira, G. Yekutieli, R. Engelmann, H. Filthuth, and W. Lughofer. 173, 1452 (1968)

SHARMA, K. C.
Ultrasonic Attenuation in Liquid Metals—K. C. Sharma. 174, 309 (1968)
Ultrasonic Attenuation in Liquid Metals. II. Dense-Gas Formulation—K. C. Sharma. 176, 319 (1968)

SHARMA, R. R.
Binding Energy of the Positronium Molecule—R. R. Sharma. 171, 36 (1968)
Zero-Field Splitting of *S*-State Ions. III. Corrections to Parts I and II and Application to Distorted Cubic Crystals—R. R. Sharma, T. P. Das, and R. Orbach. 171, 378 (1968)
Spin-Lattice Coupling Constants of an $Fe^{3+}$ Ion in MgO—R. R. Sharma. 176, 467 (1968)

SHARMA, Ravi D.
Two-Boson-Exchange Effects in Nucleon-Nucleon Scattering—Richard D. Haracz and Ravi D. Sharma. 176, 2013 (1968)

SHASTRY, C. S.
Regge-Type Representations for Coulomb-Nuclear *S* Matrix—C. S. Shastry and R. K. Satpathy. 175, 1544 (1968)
Analysis of Nuclear Scattering by Regge Poles—R. Shanta and C. S. Shastry. 176, 1254 (1968)

SHAW, Robert W., Jr.
Amplitude-Independent Longitudinal Ultrasonic Attenuation in Superconducting Lead—W. A. Fate, R. W. Shaw, and G. L. Salinger. 172, 413 (1968)
Ultrasonic Attenuation in Superconducting Mercury and Mercury-Cadmium Single Crystals—C. P. Newcomb and R. W. Shaw. 173, 509 (1968)
Optimum Form of a Modified Heine-Abarenkov Model Potential for the Theory of Simple Metals—Robert W. Shaw, Jr. 174, 769 (1968)
Ultrasonic Attenuation in the Superconducting State of High-Purity Thallium—H. J. Willard, Jr., R. W. Shaw, and G. L. Salinger. 175, 362 (1968)

SHAWHAN, D.
Proton-Neutron Triple Scattering at 425 MeV. I.—S. C. Wright, D. Shawhan, L. Pondrom, S. Olsen, and R. Handler. 175, 1704 (1968)

SHAY, J. L.
Photoemission Study of the Electronic Structure of ZnTe—J. L. Shay and W. E. Spicer. 175, 741 (1968)
Erratum: Photoemission Study of the Electronic Structure of Wurtzite CdSe and CdS—J. L. Shay and W. E. Spicer. [169, 650 (1968)] 175, 1232 (1968)

SHE, C. Y.
Symmetrical Formulation of the Quantum Theory of Three-Wave Optical Parametric Interactions—C. Y. She. 176, 461 (1968)

SHEARIN, P. E.
Recovery of Resistivity of Pure and Alloyed Aluminum in Stages II and III after 2-MeV Electron Irradiation—P. B. Peters and P. E. Shearin. 174, 691 (1968)

SHEFFEY, D. W.
Excitation Functions for Radioactive Isotopes Produced by Proton-Induced Reactions in Silicon—D. W. Sheffey, I. R. Williams, and C. B. Fulmer. 172, 1094 (1968)

SHELINE, Raymond K.
Nuclear Levels in $^{142}$Pr—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)

SHEN, C. S.
Antiprotons and Positrons in Cosmic Rays—C. S. Shen and G. B. Berkey. 171, 1344 (1968)

SHEN, L.
Nuclear Magnetic Relaxation of $F^{19}$ in Rare-Earth-Doped $LaF_3$—L. Shen. 172, 259 (1968)

SHEPARD, Harvey K.
Analyticity and the Daughter Structure of Conspiring Regge-Pole Families—Lorella Jones and Harvey K. Shepard. 175, 2117 (1968)

SHEPARD, Kenneth W.
Complex Radio-Frequency Impedance of Type-II Superconductors—George E. Possin and Kenneth W. Shepard. 171, 458 (1968)

SHEPHARD, W. D.
Compilation of $\pi^- p$ Data at 4 GeV/*c*: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

SHEPHERD, B. J.
Intensities and Angular Distributions of Ground-State Rotational Transitions Excited in $(\alpha,3n)$ and $(\alpha,4n)$ Reactions—C. F. Williamson, S. M. Ferguson, B. J. Shepherd, and I. Halpern. 174, 1544 (1968)

SHEPPARD, D. M.
Energy Levels of $^{48}$Sc—W. J. McDonald, J. T. Sample, D. M. Sheppard, G. M. Stinson, and K. W. Jones. 171, 1254 (1968)

SHERICK, A. Daniel
$C^{12}(\gamma,p)B^{11}$ Angular Distributions In and Just Above the Giant Resonance—David E. Frederick and A. Daniel Sherick. 176, 1177 (1968)

SHERWOOD, R. C.
Magnetic Properties of the Planar Antiferromagnet $Rb_2FeF_4$—G. K. Wertheim, H. J. Guggenheim, H. J. Levinstein, D. N. E. Buchanan, and R. C. Sherwood. 173, 614 (1968)

SHIEH, Shuang-Yuan
Boundary Conditions in Maxwell's Theory—Shuang-Yuan Shieh. 172, 1310 (1968)

SHIELD, E.
Proton-Proton Elastic Scattering between 6 and 10 MeV—R. J. Slobodrian, H. E. Conzett, E. Shield, and W. F. Tivol. 174, 1122 (1968)

SHIER, J. S.
Temperature-Dependent Isomer Shift and Anharmonic Binding of $Sn^{119}$ in $Nb_3Sn$ from Mössbauer-Effect Measurements—J. S. Shier and R. D. Taylor. 174, 346 (1968)

SHIMIZU, Sakae
Single-Quantum Annihilation of Positrons—Hiromasa Mazaki, Masatsugu Nishi, and Sakae Shimizu. 171, 408 (1968)
Radiationless Annihilation of Positrons in Lead—Sakae Shimizu, Takeshi Mukoyama, and Yasuyuki Nakayama. 173, 405 (1968)

SHIN, Ernest E. H.
Wave Equations with Broken $U(3,1)$ Symmetry—Ernest E. H. Shin. 171, 1652 (1968)

SHINE, M. C.
ac Dielectric Investigations of the Gyulai-Hartly Effect: Enhanced Conductivity in Alkali Halides following Plastic Deformation—M. C. Shine and R. K. MacCrone. 176, 1076 (1968)

SHIRANE, G.
Phonon Spectrum of hcp $He^4$—V. J. Minkiewicz, T. A. Kitchens, F. P. Lipschultz, R. Nathans, and G. Shirane. 174, 267 (1968)

SHIRLEY, D. A.
Three-Quasiparticle Intruder State in $Te^{125}$ and the Magnetic Moment of $Sb^{125}$—N. J. Stone, R. B. Frankel, and D. A. Shirley. 172, 1243 (1968)
SHORE, Bruce W.
Parametrization of Absorption-Line Profiles—Bruce W. Shore. 171, 43 (1968)
SHRIVASTAVA, P. N.
Neutron Cross-Section Measurements of $^{12}C$ between 14 and 25 MeV—F. Boreli, B. B. Kinsey, and P. N. Shrivastava. 174, 1147 (1968)
Proton and Neutron Resonances in Nitrogen—F. Boreli, P. N. Shrivastava, B. B. Kinsey, and V. C. Mistry. 174, 1221 (1968)
SHTRIKMAN, S.
Theory of Gyrotropic Birefringence—R. M. Hornreich and S. Shtrikman. 171, 1065 (1968)
Erratum: Theory of Magnetically Induced Electric Field Gradients in Cubic $Fe^{2+}$—U. Ganiel and S. Shtrikman. [167, 258 (1968)] 173, 630 (1968)
SHUGART, C. G.
$^{31}P(d,\alpha)^{29}Si$ Reaction from 7.3 to 12.0 MeV—G. A. Lock, J. R. Curry, P. J. Riley, and C. G. Shugart. 176, 1293 (1968)
SHUGART, Howard A.
Hyperfine Structure of $^{67}Ga$ and $^{72}Ga$—Vernon J. Ehlers, Yurdanur Kabasakal, Howard A. Shugart, and Orhan Tezer. 176, 25 (1968)
SHWE, Hla
Study of the $Nb^{93}(n_{res},\gamma)Nb^{94}$ Reaction—W. V. Prestwich, R. E. Coté, and Hla Shwe. 174, 1421 (1968)
Neutron Resonances of $Th^{230}$—R. E. Coté, H. Diamond, J. E. Gindler, and Hla Shwe. 176, 1421 (1968)
SIBLEY, W. A.
Color Centers in $MgF_2$—W. A. Sibley and O. E. Facey. 174, 1076 (1968)
SIEVERS, A. J.
Far-Infrared Properties of Lattice Resonant Modes. II. Stress Effects—I. G. Nolt and A. J. Sievers. 174, 1004 (1968)
SIGNELL, P. S.
Nucleon-Nucleon Models, Charge Splitting, and the Nucleon-Nucleon Data near 210 MeV—M. D. Miller, P. S. Signell, and N. R. Yoder. 176, 1724 (1968)
SIKKELAND, Torbjorn
Analysis of Excitation Functions in $Cm(C,xn)No$ Reactions—Torbjorn Sikkeland, Albert Ghiorso, and Matti J. Nurmia. 172, 1232 (1968)
SILBAR, R. R.
Two-Body $\bar{K}d$ Reactions as a Test of One-Meson Exchange—M. E. Schillaci and R. R. Silbar. 171, 1764 (1968)
SILBERGLITT, Richard
Dynamics of the Heisenberg Ferromagnet at Low Temperature—Richard Silberglitt and A. Brooks Harris. 174, 640 (1968)
SILBEY, Robert
Accurate Atomic and Molecular Wave Functions Without Exchange—Jeremy I. Musher and Robert Silbey. 174, 94 (1968)
SILVA, J. Andrade e
Interpretation of a Recent Experiment on Interference of Photon Beams—Louis de Broglie and J. Andrade e Silva. 172, 1284 (1968)
SILVA, R. J.
11-MeV Proton Optical-Model Analysis—C. M. Perey, F. G. Perey, J. K. Dickens, and R. J. Silva. 175, 1460 (1968)
SILVER, J. E.
Distribution of Blackbody Cavity Radiation in a Moving Frame of Reference—G. R. Henry, R. B. Feduniak, J. E. Silver, and M. A. Peterson. 176, 1451 (1968)
SILVERSTEIN, S. D.
Theory of the Tunneling Spectroscopy of Collective Excitations—Alan J. Bennett, C. B. Duke, and S. D. Silverstein. 176, 969 (1968)
SIMMONS, R. O.
Equilibrium Vacancy Concentration Measurements on Solid Krypton—D. L. Losee and R. O. Simmons. 172, 934 (1968)
Thermal-Expansion Measurements and Thermodynamics of Solid Krypton—D. L. Losee and R. O. Simmons. 172, 944 (1968)
Isotope Effects in the Lattice Constant and Thermal Expansion of $^{20}Ne$ and $^{22}Ne$ Single Crystals—D. N. Batchelder, D. L. Losee, and R. O. Simmons. 173, 873 (1968)
SIMON, H. J.
Second-Harmonic Light Generation in Crystals with Natural Optical Activity—H. J. Simon and N. Bloembergen. 171, 1104 (1968)
SIMONSEN, H.
Stopping Power of the Elements $Z=20$ Through $Z=30$ for 5–12-MeV Protons and Deuterons—H. H. Andersen, C. C. Hanke, H. Simonsen, H. Sørensen, and P. Vajda. 175, 389 (1968)
SIMS, W. H.
$\pi^- p$ Elastic Scattering at 2.26 GeV/c—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)
SINCLAIR, A. C. E.
Ultrasonic Investigation of the Isolated-Vortex State near $H_{C1}$ in Vanadium—A. C. E. Sinclair and J. R. Leibowitz. 175, 596 (1968)
SINCLAIR, F. D.
Gyromagnetic Ratio of Helium $2^3S_1$ Atoms by Optical Pumping: Level Shifts—L. D. Schearer and F. D. Sinclair. 175, 36 (1968)
SINGH, C. P.
Rescattering Model Applied to $Y^*$ Production—C. P. Singh and B. K. Agarwal. 173, 1611 (1968)
SINGH, K. P.
Magnetically Induced Quadrupole Interactions in $FeCr_2S_4$—Gilbert R. Hoy and K. P. Singh. 172, 514 (1968)
SINGH, M. P.
Stored-Energy Release in Electron-Irradiated Germanium—M. P. Singh and J. W. MacKay. 175, 985 (1968)
SINGH, R. P.
Phonon Conductivity and Acoustic Attenuation in Si—R. P. Singh and G. S. Verma. 171, 838 (1968)
SINGH, Y.
Phenomenological Analysis of Weak-Radiative Decay of the $K^+$ Meson and $CP$-Noninvariant Effects—Y. Singh. 175, 2214 (1968)
SINGWI, K. S.
Electron Correlations at Metallic Densities—K. S. Singwi, M. P. Tosi, R. H. Land, and A. Sjölander. 176, 589 (1968)
SINHA, K. P.
Possibility of Photoinduced Superconductivity—N. Kumar and K. P. Sinha. 174, 482 (1968)
SIRLIN, A.
Divergent Part of the Second-Order Electromagnetic Corrections to the Ratio $G_A/G_V$—A. Sirlin. 176, 1871 (1968)
SJÖLANDER, A.
Electron Correlations at Metallic Densities—K. S. Singwi, M. P. Tosi, R. H. Land, and A. Sjölander. 176, 589 (1968)

SKELTON, Earl F.
Examination of the Thermal Variation of the Mean Square Atomic Displacements in Zinc and Evaluation of the Associated Debye Temperature—Earl F. Skelton and J. Lawrence Katz. 171, 801 (1968)

SKJEGGESTAD, O.
Measurement of the Lifetime of the Short-Lived Neutral $K$ Meson—D. G. Hill, D. K. Robinson, M. Sakitt, O. Skjeggestad, J. Canter, Y. Cho, A. Dralle, A. Engler, H. E. Fisk, R. W. Kraemer, and C. M. Meltzer. 171, 1418 (1968)

SKLAREW, Ralph C.
Elastic Scattering of Low-Energy Electrons from Metastable Helium—Ralph C. Sklarew and Joseph Callaway. 175, 103 (1968)

SKOVE, M. J.
Measurement of Higher-Order Elastic Constants, Using Finite Deformations—B. E. Powell and M. J. Skove. 174, 977 (1968)

SLADEK, R. J.
Magnetoresistance of Undoped $n$-Type Gallium Arsenide at Low Temperatures—L. Halbo and R. J. Sladek. 173, 794 (1968)

SLANSKY, Richard C.
A Sum Rule Based on Unitarity—Farzam Arbab and Richard C. Slansky. 171, 1785 (1968)
Crossing-Symmetric Rising Regge Trajectories—Shu-Yuan Chu, Gary Epstein, Peter E. Kaus, Richard C. Slansky, and Fredrik Zachariasen. 175, 2098 (1968)

SLATER, D. C.
Nuclear-Reaction Studies in the Strontium Isotopes: Neutron Particle-Hole States in $Sr^{88}$ and the $Sr^{87}(d,p)Sr^{88}$ Reaction—E. R. Cosman and D. C. Slater. 172, 1126 (1968)

SLAVIK, C. J.
Coupled-Channel Calculation of $C^{12}$-Neutron Scattering—J. T. Reynolds, C. J. Slavik, C. R. Lubitz, and N. C. Francis. 176, 1213 (1968)

SLEEPER, Arthur
Trajectory and Mass Shift of a Classical Electron in a Radiation Pulse—Joseph H. Eberly and Arthur Sleeper. 176, 1570 (1968)

SLOBODRIAN, R. J.
Proton-Proton Elastic Scattering between 6 and 10 MeV—R. J. Slobodrian, H. E. Conzett, E. Shield, and W. F. Tivol. 174, 1122 (1968)

SMALLEY, L. L.
Current Commutation Relations in $R(11)$—L. L. Smalley and D. W. Joseph. 174, 1937 (1968)

SMITH, Alfred R.
Low-Temperature Magnetic Anisotropy in $Al_2O_3:V^{3+}$—Alfred R. Smith and Raymond W. Mires. 172, 265 (1968)

SMITH, B. L.
Self-Diffusion in Solid Argon—E. H. C. Parker, H. R. Glyde, and B. L. Smith. 176, 1107 (1968)

SMITH, Gerald A.
Search for a $2\pi^0$ Resonance near 730 MeV in $\pi^+d$ Interactions—Gerald A. Smith and Robert J. Manning. 171, 1399 (1968)

SMITH, Granville J., II
$n$-Particle Kinematics and a Generalized Partial-Wave Analysis—William H. Klink and Granville J. Smith II. 175, 2010 (1968)

SMITH, Henrik
Ginzburg-Landau Theory of Surface Superconductivity and Magnetic Hysteresis—P. Voetmann Christiansen and Henrik Smith. 171, 445 (1968)

SMITH, J. H.
Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)

SMITH, J. P.
High-Temperature Recovery of Tungsten after Neutron Irradiation—L. K. Keys, J. P. Smith, and J. Moteff. 176, 851 (1968)

SMITH, T.
Lattice Dynamics and Ionic Deformation in Some Alkali Halides—J. S. Melvin, J. D. Pirie, and T. Smith. 175, 1082 (1968)

SMITH, T.
Linear Chain Antiferromagnetism in $CsMnCl_3 \cdot 2H_2O$—T. Smith and S. A. Friedberg. 176, 660 (1968)

SMITH, T. F.
Superconductivity of $\alpha$-Phase U-Mo Alloys at Zero and High Pressures—J. E. Gordon, W. E. Gardner, T. F. Smith, C. W. Chu, and M. B. Maple. 176, 556 (1968)

SMITH, William R.
Capture and Elastic Scattering of Protons by $^{14}C$—Jerry D. Henderson, Emmett L. Hudspeth, and William R. Smith. 172, 1058 (1968)

SNELGROVE, J. L.
Precise Energies of $^{40}Ca$ Levels—E. Kashy and J. L. Snelgrove. 172, 1124 (1968)

SNIDER, D. R.
$O(4)$ Symmetry and the Regge Trajectory of the Pion—W. R. Frazer, H. M. Lipinski, and D. R. Snider. 174, 1932 (1968)
$O(4)$ Expansion of Off-Shell Scattering Amplitudes—W. R. Frazer, F. R. Halpern, H. M. Lipinski, and D. R. Snider. 176, 2047 (1968)
$O(4)$ Symmetry, $N\bar{N}$ Scattering, and the Regge Trajectory of the Pion—H. M. Lipinski and D. R. Snider. 176, 2054 (1968)

SNODGRASS, H. B.
Adiabatic Approximation and Necessary Conditions for the Existence of Bound States—F. H. Gertler, H. B. Snodgrass, and Larry Spruch. 172, 110 (1968)

SNOVER, K. A.
Magnetic Dipole Transitions and Isospin in $Be^8$—P. Paul, D. Kohler, and K. A. Snover. 173, 919 (1968)

SNOW, E. C.
Self-Consistent Energy Bands of Metallic Copper by the Augmented-Plane-Wave Method. II.—E. C. Snow. 171, 785 (1968)
Self-Consistent Energy Bands of Silver by an Augmented-Plane-Wave Method—E. C. Snow. 172, 708 (1968)

SNOW, Joel Alan
High-Frequency Sound Absorption in Superconductors—Joel Alan Snow. 172, 455 (1968)

SODEN, R. R.
High-Field Galvanomagnetic Properties of Niobium—W. A. Reed and R. R. Soden. 173, 677 (1968)

SOFFER, Stephen B.
Anomalous Size Effects in the Galvanomagnetic Properties of Zinc Caused by Compensation—Stephen B. Soffer. 176, 861 (1968)

SOKOLOFF, J. B.
Polar Spin Waves in Ferromagnetic Metals—J. B. Sokoloff. 173, 617 (1968)

SOLIN, S. A.
Raman Spectrum of Crystalline Benzil—S. A. Solin and A. K. Ramdas. 174, 1069 (1968)

SOLLFREY, William
Note on Nonlinear Realizations of Chiral Symmetry—William Solfrey. 173, 1805 (1968)

SOLLID, J. E.
Relativistic Corrections to the Light-Scattering Spectrum of a Plasma—O. Theimer and J. E. Sollid. 176, 198 (1968)

SOLOMON, J.
Double Charge Exchange of Positive π Mesons on Complex Nuclei—P. E. Boynton, Thomas J. Devlin, J. Solomon, and V. Perez-Mendez. 174, 1083 (1968)

SOLOVIEV, L.
Low-Energy-Theorem Approach to Single-Particle Singularities in the Presence of Massless Bosons—R. Jackiw and L. Soloviev. 173, 1485 (1968)

ŠOLN. J.
Nonlocal Currents as Coordinates for Particles—J. Šoln. 171, 1773 (1968)

SOLTESZ, C. R.
Polarization of the Neutrons from the $^{12}C(d,n)^{13}N$ Reaction at the 4-MeV Resonance and between 5.2 and 6.2 MeV—T. R. Donoghue, W. L. Baker, P. L. Beach, D. C. DeMartini, and C. R. Soltesz. 173, 952 (1968)

SOLTYSIK, Edward A.
Polarization of Light from Collisions of a Proton Beam with Helium Atoms—Daniel Krause, Jr., and Edward A. Soltysik. 175, 142 (1968)

SÓLYOM, J.
Magnetic Structures and Exchange Interactions in the Mn–Pt System—E. Krén, G. Kádár, L. Pál, J. Sólyom, P. Szabó, and T. Tarnóczi. 171, 574 (1968)

SOMMERFIELD, Charles M.
Currents as Dynamical Variables—Charles M. Sommerfield. 176, 2019 (1968)

SOOTHA, G. D.
Optical, Electron-Spin-Resonance, and Electrical Studies of Colloidal and *F*-Aggregate Centers in Highly Pure KCl Crystals. I. Colloidal Centers—S. C. Jain and G. D. Sootha. 171, 1075 (1968)
Optical, Electron-Spin-Resonance, and Electrical Studies of Colloidal and *F*-Aggregate Centers in Highly Pure KCl Crystals. II. *F*-Aggregate Centers—S. C. Jain and G. D. Sootha. 171, 1083 (1968)

SØRENSEN, H.
Stopping Power of the Elements $Z=20$ Through $Z=30$ for 5–12-MeV Protons and Deuterons—H. H. Andersen, C. C. Hanke, H. Simonsen, H. Sørensen, and P. Vajda. 175, 389 (1968)

SOUTHWELL, W. H.
Mössbauer-Effect Measurements in Iron at High Pressures—W. H. Southwell, D. L. Decker, and H. B. Vanfleet. 171, 354 (1968)

SPEARMAN, T. D.
Process $\pi^- p \to \pi^+\pi^- n$ near Threshold—S. Humble and T. D. Spearman. 171, 1724 (1968)

SPECTOR, Richard M.
Baryon Resonances and Regge Trajectories—Richard M. Spector. 173, 1761 (1968)

SPEDDING, F. H.
Neutron Diffraction and Susceptibility Study of Dilute La–Rare-Earth Alloys—D. K. Finnemore, L. J. Williams, F. H. Spedding, and D. C. Hopkins. 176, 712 (1968)

SPEISER, D. R.
Statistical Model for High-Energy Reactions—L. L. Foldy, H. Kottler, D. R. Speiser, and J. Weyers. 173, 1517 (1968)

SPENCER, H. J.
Theory of *s–d* Scattering in Dilute Magnetic Alloys with Spin-$\frac{1}{2}$ Impurities—H. J. Spencer. 171, 515 (1968)

SPENCER, R. R.
A $K^\pi = 0^+$ Band in $^{184}W$—K. T. Faler, R. R. Spencer, and R. A. Harlan. 175, 1495 (1968)

SPERINDE, John
$\pi^-$-$^4$He Inelastic and Capture Reactions Leading to Excited and Multineutron Final States—Leon Kaufman, Victor Perez-Mendez, and John Sperinde. 175, 1358 (1968)

SPICER, W. E.
Optical Properties of Platinum—A. Y-C. Yu, W. E. Spicer, and G. Hass. 171, 834 (1968)
Erratum: Optical Properties of Cobalt—A. Y-C. Yu, T. M. Donovan, and W. E. Spicer. [167, 670 (1968)] 172, 1002 (1968)
Erratum: Photoemission Studies of the Electronic Structure of Cobalt—A. Y-C. Yu and W. E. Spicer: [167, 674 (1968)] 172, 1002 (1968)
Spectral Analysis of Photoemissive Yields in GaAs and Related Crystals—Frank Herman and W. E. Spicer. 174, 906 (1968)
Location of the $L_1$ and $X_3$ Minima in GaAs as Determined by Photoemission Studies—L. W. James, R. C. Eden, J. L. Moll, and W. E. Spicer. 174, 909 (1968)
Photoemission Study of the Electronic Structure of ZnTe—J. L. Shay and W. E. Spicer. 175, 741 (1968)
Erratum: Photoemission Study of the Electronic Structure of Wurtzite CdSe and CdS—J. L. Shay and W. E. Spicer. [169, 650 (1968)] 175, 1232 (1968)

SPINOLO, G.
Data and Speculations on the Electronic Problem for the Relaxed Excited *F* Center—L. Bosi, P. Podini, and G. Spinolo. 175, 1133 (1968)

SPRUCH, Larry
Adiabatic Approximation and Necessary Conditions for the Existence of Bound States—F. H. Gertler, H. B. Snodgrass, and Larry Spruch. 172, 110 (1968)

SPRUNG, W. L.
Relative Proton Number in Neutron Star Matter—J. Nemeth and Donald W. L. Sprung. 176, 1496 (1968)

SPRY, Robert J.
Recombination Luminescence in Irradiated Silicon—Robert J. Spry and W. Dale Compton. 175, 1010 (1968)

SRINIVASAN, B.
Xenon-134 from the Decay of Cesium-134—E. C. Alexander, Jr., G. A. Bennett, B. Srinivasan, and O. K. Manuel. 175, 1494 (1968)

SRIVASTAVA, B. N.
Measurements of the Electron Impact Excitation Cross Section of $N_2^+$ First Negative Bands—B. N. Srivastava and I. M. Mirza. 176, 137 (1968)

STACK, John D.
Conspiracy Relations for Unequal-Mass Processes—John D. Stack. 171, 1666 (1968)
Equal-Mass Conspiracy Relations as the Limit of the Unequal-Mass Case—John D. Stack. 173, 1644 (1968)

STAMMBACH, Th.
Determination of the Neutron Polarization from the $^{13}C(^3He,n)^{15}O_{g.s.}$ Reaction from 2.9 to 3.9 MeV—Th. Stammbach, R. S. Thomason, J. Taylor, Jr., and R. L. Walter. 174, 1119 (1968)

STANLEY, H. E.
Spherical Model as the Limit of Infinite Spin Dimensionality—H. E. Stanley. 176, 718 (1968)

STAPLETON, H. J.
Modified Orbach Relaxation Process in a $La(Cl, Br)_3$ Matrix—B. A. Young and H. J. Stapleton. 176, 502 (1968)

STAPP, Henry P.
Kinematic Constraints on Helicity Amplitudes—Henry P. Stapp. 174, 2091 (1968)

STEBBINGS, R. F.
Lyman-$\alpha$ Production and Polarization in $He^+$ Collisions with H and $H_2$—Robin A. Young, R. F. Stebbings, and J. William McGowan. 171, 85 (1968)
STEEN, Charles F.
Lattice-Dynamical Properties of $Fe^{57}$ Impurity Atoms in Pt, Pd, and Cu from Precision Measurements of Mössbauer Fractions—Rudi H. Nussbaum, Donald G. Howard, Wilbur L. Nees, and Charles F. Steen. 173, 653 (1968)
STEFANSKI, R. J.
Search for Heavy Triplets in Cosmic Rays—H. Kasha and R. J. Stefanski. 172, 1297 (1968)
STEHLE, P.
Emission of Radiation from a System of Many Excited Atoms—V. Ernst and P. Stehle. 176, 1456 (1968)
STEIN, Nelson
Two-Neutron-Hole Configurations in $Pb^{208}$ from Isobaric Analog Measurements—Patrick Richard, Nelson Stein, C. D. Kavaloski, and J. S. Lilley. 171, 1308 (1968)
STEIN, T. S.
Electric Dipole Moments of Alkali Atoms. A Limit to the Electric Dipole Moment of the Free Electron—J. P. Carrico, E. Lipworth, P. G. H. Sandars, T. S. Stein, and M. C. Weisskopf. 174, 125 (1968)
STEINBERG, P.
Measurement of the Branching Ratio for the Decay $K^+ \to e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \to \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)
STEINBRECHER, György
Calculation of Elastic Scattering Amplitude by Conformal Mapping—György Steinbrecher. 174, 1794 (1968)
STEINER, Bruce
The Cross Section for the Photodetachment of Electrons from $I^-$—Bruce Steiner. 173, 136 (1968)
STEINRISSER, F.
Electron and Phonon Tunneling Spectroscopy in Metal-Germanium Contacts—F. Steinrisser, L. C. Davis, and C. B. Duke. 176, 912 (1968)
STELL, G.
Homogeneity of the Correlation Length in the Critical Region—G. Stell. 173, 314 (1968)
STELTS, Marion L.
Two-Particle, Two-Hole States in $^{40}K$ from the Study of the $^{43}Ar(^3He,^3H)^{40}K$ Reaction—J. J. Wesolowski, Luisa F. Hansen, and M. L. Stelts. 172, 1072 (1968)
Study of the Two-Body Force through the $(He^3,t)$ Charge-Exchange Reaction on $O^{17}$ and $O^{18}$—Luisa F. Hansen, Marion L. Stelts, Jose G. Vidal, J. J. Wesolowski, and V. A. Madsen. 174, 1155 (1968)
STELZER, E. L.
Magnetoresistance in Semiconducting Strontium Titanate—O. N. Tufte and E. L. Stelzer. 173, 775 (1968)
STEPHEN, M. J.
Photon Echo in Gaseous Media—M. Scully, M. J. Stephen, and David C. Burnham. 171, 213 (1968)
STEPHENS, P. J.
Zeeman Study of the Jahn-Teller Effect in the $^3T_{2g}$ State of $Al_2O_3:V^{3+}$—P. J. Stephens and Marian Lowe-Pariseau. 171, 322 (1968)
STEPHENSON, R. L.
Free Energy of the Classical Heisenberg Model—R. L. Stephenson and P. J. Wood. 173, 475 (1968)
STEPIŠNIK, J.
Nuclear-Magnetic-Resonance Study of the Ferroelectric Transitions in $NaH_3(SeO_3)_2$ and $NaD_3(SeO_3)_2$—R. Blinc, J. Stepišnik, and I. Zupančič. 176, 732 (1968)
STERNHEIM, M. M.
Optical-Model Analysis of Pion-Nucleus Scattering. II. Pion Form Factor—E. H. Auerbach, D. M. Fleming, and M. M. Sternheim. 171, 1781 (1968)
STERNHEIMER, R. M.
Shielding of Crystal Fields at Rare-Earth Ions—R. M. Sternheimer, M. Blume, and R. F. Peierls. 173, 376 (1968)
STEWART, W. M.
Core Excitations in $^{107}Ag$, $^{109}Ag$, $^{113}In$, $^{115}In$, $^{121}Sb$, and $^{123}Sb$ Resulting from Inelastic Scattering of 42-MeV Alpha Particles—W. M. Stewart, N. Baron, and R. F. Leonard. 171, 1316 (1968)
STILES, P. J.
Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)
Effects of a Tilted Magnetic Field on a Two-Dimensional Electron Gas—F. F. Fang and P. J. Stiles. 174, 823 (1968)
STINSON, G. M.
Energy Levels of $^{46}Sc$—W. J. McDonald, J. T. Sample, D. M. Sheppard, G. M. Stinson, and K. W. Jones. 171, 1254 (1968)
STOKES, Richard H.
Search for the Ground State of $^5H$ by means of the $^3H(t,p)$ Reaction—P. G. Young, Richard H. Stokes, and Gerald G. Ohlsen. 173, 949 (1968)
Search for States in the Three-Neutron and Triton Systems—Gerald G. Ohlsen, Richard H. Stokes, and P. G. Young. 176, 1163 (1968)
STONE, N. J.
Three-Quasiparticle Intruder State in $Te^{125}$ and the Magnetic Moment of $Sb^{125}$—N. J. Stone, R. B. Frankel, and D. A. Shirley. 172, 1243 (1968)
STONEHAM, A. M.
Ion-Size Effects in Color Centers—R. H. Bartram, A. M. Stoneham, and Philip Gash. 176, 1014 (1968)
STORER, R. G.
Correlation Function in a Plasma at Zero Particle Separation—B. Davies and R. G. Storer. 171, 150 (1968)
Radial Distribution Function for a Quantum Plasma—R. G. Storer. 176, 326 (1968)
STOTLAND, V. G.
$^{16}O(\alpha,2\alpha)^{12}C_{g.s.}$ Reaction Mechanisms near 25 MeV—A. W. Parker, J. S. Allen, R. L. Yerke, and V. G. Stotland. 174, 1093 (1968)
STRANAHAN, G.
Critical-Point Behavior of a Model Describing a System of Interacting Fermions—S. Gartenhaus and G. Stranahan. 173, 260 (1968)
STRANDBERG, M. W. P.
Effect of Phonon Dispersion on Heat-Pulse Shape—J. M. Andrews, Jr., and M. W. P. Strandberg. 172, 869 (1968)
STRATHDEE, J.
Reggeization of Quark Number—R. Delbourgo, Abdus Salam, and J. Strathdee. 172, 1727 (1968)
STRATTON, R.
Influence of Ellipsoidal Energy Surfaces on the Differential Resistance of Schottky Barriers—R. Stratton and F. A. Padovani. 175, 1072 (1968)

STRAUB, R.
Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/$c$—A. Fridman, G. Maurer, A. Michalon, J. Oudet, R. Straub, C. Voltolini, and P. Cüer. 176, 1595 (1968)
STREET, K.
Isomer Ratio of $Ce^{137m}$ to $Ce^{137g}$ Produced in Several Charged-Particle Reactions—R. L. Kiefer and K. Street, Jr. 173, 1202 (1968)
STREEVER, R. L.
Nuclear-Magnetic-Resonance Studies of $Mn^{55}$ in Ni–Mn Alloys—R. L. Streever. 173, 591 (1968)
STRENZWILK, Denis F.
Calculation of the Sublattice Magnetization of Yttrium Iron Garnet by the Oguchi Method—Denis F. Strenzwilk and Elmer E. Anderson. 175, 654 (1968)
STRINGFELLOW, Gerald B.
Photoelectronic Properties of ZnSe Crystals—Gerald B. Stringfellow and Richard H. Bube. 171, 903 (1968)
STROCCHI, F.
$T$-Violation Effects and Final-State Interactions—G. Karpman, R. Leonardi, and F. Strocchi. 174, 1957 (1968)
STROM, P. O.
Cumulative Fission Yield and Half-Life of $^{134}Sb$—A. A. Delucchi, A. E. Greendale, and P. O. Strom. 173, 1159 (1968)
STRÖMER, K.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)
STROUD, D.
Assumption-Independent Single-Particle Wave Function for Positrons in Solids: Applications to Angular Distributions in Al and Si—D. Stroud and H. Ehrenreich. 171, 399 (1968)
STRUBLE, Gordon L.
Nuclear Levels in $^{142}Pr$—Jean Kern, Gordon L. Struble, Raymond K. Sheline, E. T. Jurney, H. R. Koch, B. P. K. Maier, U. Gruber, and O. W. B. Schult. 173, 1133 (1968)
STRUZYNSKI, R. E.
Microscopic Quantum Hydrodynamics for Interacting Bose Systems—Robert Fanelli and R. E. Struzynski. 173, 248 (1968)
STURGE, M. D.
Effect of Stress on the Trigonal Splittings of $d^3$ Ions in Sapphire ($\alpha$-$Al_2O_3$)—Elsa Feher and M. D. Sturge. 172, 244 (1968)
SUDARSHAN, E. C. G.
Lorentz Invariance, Local Field Theory, and Faster-than-Light Particles—M. E. Arons and E. C. G. Sudarshan. 173, 1622 (1968)
Quantum Field Theory of Interacting Tachyons—J. Dhar and E. C. G. Sudarshan. 174, 1808 (1968)
SUGANO, R.
Superconvergence Relations and Possible New Resonances in Pion-Baryon Scattering—D. Kiang, W. C. Lin, R. Sugano, H. E. Lin, and Y. Nogami. 176, 2159 (1968)
SUGAR, R. L.
Feynman-Diagram Models of Regge-Pole Conspiracies—R. Blankenbecler, R. L. Sugar, and J. D. Sullivan. 172, 1451 (1968)
SUGAWARA, Hirotaka
Zero-Parameter Model of the $N$-$N$ Potential—Hirotaka Sugawara and Frank von Hippel. 172, 1764 (1968)
Theory of Currents, $\sigma$ Model, and the Spherical Top in the Internal Space—H. Sugawara and M. Yoshimura. 173, 1419 (1968)
SUGAWARA, Masao
Off-Mass-Shell Approach to Strong Decays of Baryon Resonances—Masao Sugawara. 172, 1423 (1968)
Off-Mass-Shell Approach to Nucleon Resonances of Spin $\frac{3}{2}$ and Isospin $\frac{1}{2}$—Masao Sugawara and James W. Meyer. 174, 1709 (1968)
SUHL, H.
Further Investigation of Local Moments in Metals—M. Levine and H. Suhl. 171, 567 (1968)
SUITOR, R.
Hard-Pion Current-Algebra Calculation of Meson Processes—$N$-Point Functions—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1802 (1968)
Application of Hard-Pion Four-Point Functions to Pion-Pion Scattering—R. Arnowitt, M. H. Friedman, P. Nath, and R. Suitor. 175, 1820 (1968)
SULLIVAN, E.
Doubly Excited States of $H^-$ of High Principal Quantum Number: Implications for Electron-Atom Ionization—A. Temkin, A. K. Bhatia, and E. Sullivan. 176, 80 (1968)
SULLIVAN, J. D.
Feynman-Diagram Models of Regge-Pole Conspiracies—R. Blankenbecler, R. L. Sugar, and J. D. Sullivan. 172, 1451 (1968)
SULLIVAN, Paul F.
Steady-State, ac-Temperature Calorimetry—Paul F. Sullivan and G. Seidel. 173, 679 (1968)
SUND, R. E.
Measurements of the $^{63}Cu(\gamma,n)$ and $(\gamma,2n)$ Cross Sections—R. E. Sund, M. P. Baker, L. A. Kull, and R. B. Walton. 176, 1366 (1968)
SUNYAR, A. W.
Time Dependence of Mössbauer Scattered Radiation—P. Thieberger, J. A. Moragues, and A. W. Sunyar. 171, 425 (1968)
SURKO, C. M.
Investigation of a New Kind of Energetic Neutral Excitation in Superfluid Helium—C. M. Surko and F. Reif. 175, 229 (1968)
SUZUKI, Mahiko
Enhancement of $SU(3)$ Breakings and Regge Trajectories—Mahiko Suzuki. 171, 1791 (1968)
Analytic Continuation of Divergent Integrals with Respect to a Parameter—The Case of Peturbations to Strong Interactions—Mahiko Suzuki. 173, 1473 (1968)
SUZUKI, Tetsuro
Second- and Third-Order Elastic Constants of Alkali Metals—Tetsuro Suzuki, A. V. Granato, and J. F. Thomas, Jr. 175, 766 (1968)
SVENNE, J. P.
Structure of the Self-Consistent Solutions for Even-Even Nuclei in the $2p$-$1f$ Shell—J. C. Parikh and J. P. Svenne. 174, 1343 (1968)
SWANN, C. P.
Gamma-Ray Widths of the 3.00-MeV Level of $Al^{27}$ and the 3.13-MeV Level of $P^{31}$—S. W. Robinson, C. P. Swann, and V. K. Rasmussen. 174, 1320 (1968)
SWANSON, R. A.
Interference between Neutral Kaons and Their Mass Difference—W. A. W. Mehlhop, S. S. Murty, P. Bowles, T. H. Burnett, R. H. Good, C. H. Holland, O. Piccioni, and R. A. Swanson. 172, 1613 (1968)
SWANSON, W. P.
$pp$ Interactions at 10 GeV/$c$—S. P. Almeida, J. G. Rushbrooke, J. H. Scharenguivel, M. Behrens, V. Blobel, I. Borecka, H. C. Dehne, J. Díaz, G. Knies, A. Schmitt, K. Strömer, and W. P. Swanson. 174, 1638 (1968)

SWENSON, C. A.
Specific Heats of Cu, GaAs, GaSb, InAs, and InSb from 1 to 30°K—T. C. Cetas, C. R. Tilford, and C. A. Swenson. 174, 835 (1968)

SWIFT, Arthur R.
Daughter Regge Trajectory in a Field-Theory Model. II—Arthur R. Swift. 171, 1466 (1968)
Intersecting Regge Trajectories in a Field-Theory Model—Arthur R. Swift. 176, 1848 (1968)

SWIFT, C. D.
Measurements of $L_2$- and $L_3$-Subshell Fluorescence Yields in Heavy Elements—Richard E. Price, Hans Mark, and C. D. Swift. 176, 3 (1968)

SWIFT, Jack
Transport Coefficients Near the Consolute Temperature of a Binary Liquid Mixture—Jack Swift. 173, 257 (1968)

SWINNEY, H. L.
Thermal Diffusivity of $CO_2$ in the Critical Region—H. L. Swinney and Herman Z. Cummins. 171, 152 (1968)

SYBERT, J. R.
Electron Transport with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey and J. R. Sybert. 172, 603 (1968)
Size Effect in Electrical Conductivity of Metallic Films with Arbitrarily Oriented Ellipsoidal Fermi Surfaces—H. J. Mackey, J. R. Sybert, and W. D. Deering. 175, 729 (1968)
Size Effect in the Electrical Conductivity of Cylindrical Wires—H. J. Mackey, W. D. Deering, and J. R. Sybert. 176, 856 (1968)

SYKES, J.
Time Evolution of the Total Distribution Function of a One-Dimensional System of Hard Rods—J. L. Lebowitz, J. K. Percus, and J. Sykes. 171, 224 (1968)

SZABÓ, P.
Magnetic Structures and Exchange Interactions in the Mn–Pt System—E. Krén, G. Kádár, L. Pál, J. Sólyom, P. Szabó, and T. Tarnóczi. 171, 574 (1968)

SZEKERES, P.
Multipole Particles in Equilibrium in General Relativity—P. Szekeres. 176, 1446 (1968)

TABAK, Mark D.
Field-Controlled Photogeneration and Free-Carrier Transport in Amorphous Selenium Films—Mark D. Tabak and Peter J. Warter, Jr. 173, 899 (1968)

TABAKIN, Frank
Single Separable Potential with Attraction and Repulsion—Frank Tabakin. 174, 1208 (1968)

TACHIKI, M.
Erratum: Electrical Resistivity and Thermoelectric Power of CuAu Alloy—K. Teramoto and M. Tachiki. [166, 656 (1968)] 172, 1002 (1968)

TADIC, D.
Weak Parity-Nonconserving Potentials—D. Tadić. 174, 1694 (1968)

TAFT, H. D.
Pion Production and Elastic Scattering in Antiproton-Proton Collisions at 6.94 BeV/$c$—T. Ferbel, J. A. Johnson, H. I. Kraybill, J. Sandweiss, and H. D. Taft. 173, 1307 (1968)

TAHA, M. O.
Parity-Conserving Hyperon Nonleptonic Decays in $SU(3)$—M. O. Taha. 171, 1481 (1968)

TAKAHASHI, Hiroshi
Screening and Electron Correlation Effects on the Electron-Phonon Interaction in Monovalent Metal—Hiroshi Takahashi. 172, 747 (1968)

TAKATSUJI, M.
Erratum: Effect of Angular Correlation on Nonlinear Refractive Index of Liquids—M. Takatsuji. [165, 171 (1968)] 172, 241 (1968)

TALBERT, W. L., Jr.
Total Internal-Conversion Coefficients for Low-Energy $E2$ Transitions in $Ra^{224}$, $Th^{228}$, $U^{234}$, $U^{236}$, and $Pu^{240}$—C. L. Duke and W. L. Talbert, Jr. 173, 1125 (1968)

TALUKDAR, Benoy
Relativistic Study of $KL_1L_1$ Auger Transition Probabilities—Dipankar Chattarji and Benoy Talukdar. 174, 44 (1968)

TAN, Chung-I
Phase Contours of Scattering Amplitudes. III. High Energy Behavior at Fixed Angles—Richard J. Eden and Chung-I Tan. 172, 1583 (1968)

TAN, Hing-Tat
Low Excited States and Statistical and Transport Properties of Liquid $He^3$—Hing-Tat Tan and E. Feenberg. 176, 370 (1968)

TAN, T. H.
Observation of $Y^{*+}(1385)K^+$ and $N^{*++}(1236)\rho^0$ Decays of a Nucleon Resonance—W. Chinowsky, P. Condon, R. R. Kinsey, S. Klein, M. Mandelkern, P. Schmidt, J. Schultz, F. Martin, M. L. Perl, and T. H. Tan. 171, 1421 (1968)
Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)

TANAKA, S.
Production of $^7$Be, $^{22}$Na, and $^{24}$Na Fragments from Heavy Elements at 3, 10, and 30 GeV—J. Hudis and S. Tanaka. 171, 1297 (1968)

TANAKA, Tomoyasu
Application of the Cluster-Variation Method to the Uniaxial Antiferromagnet $FeF_2$—Tomoyasu Tanaka, Louis Libelo, and Ronald Kligman. 171, 531 (1968)
Application of the Cluster Variation Method to the $s$-$d$ Interaction Hamiltonian—James Halow, Tomoyasu Tanaka, and Tohru Morita. 175, 680 (1968)
Ground-State Energy of the Anderson Model by the Cluster Variation Method—Shyamalendu M. Bose and Tomoyasu Tanaka. 176, 600 (1968)

TANENBAUM, B. Samuel
Continuum Theory of Thomson Scattering—B. Samuel Tanenbaum. 171, 215 (1968)

TANG, C. L.
Erratum: Quantum Theory of Spontaneous Parametric Scattering of Intense Light—T. G. Giallorenzi and C. L. Tang. [166, 225 (1968)] 171, 610 (1968)

TANG, H.
Light Shifts in the Alkali Atoms—B. S. Mathur, H. Tang, and W. Happer. 171, 11 (1968)

TANG, K. T.
Padé-Approximant Calculation of the Nonretarded van der Waals Coefficients for Two and Three Helium Atoms—K. T. Tang and M. Karplus. 171, 70 (1968)

TANG, Y. C.
Nuclear-Matter Radii from a Reformulated Optical Model—G. W. Greenlees, G. J. Pyle, and Y. C. Tang. 171, 1115 (1968)
Investigation of Nuclear Three- and Four-Body Systems with Soft-Core Nucleon-Nucleon Potentials—I. R. Afnan and Y. C. Tang. 175, 1337 (1968)
Comparison of Variational Results and Solutions of Faddeev Equation for a Local Potential—I. R. Afnan and Y. C. Tang. 176, 1232 (1968)

Study of $He^3$+$He^4$ and $H^3$+$He^4$ Systems with the Resonating-Group Method—Ronald E. Brown and Y. C. Tang. 176, 1235 (1968)

TANI, S.
Many-Level Formula for Scattering from Extremely Strong Square Potentials—S. Tani. 174, 2054 (1968)

TAPPER, M. L.
Consequences of the Modified Hypothesis of Partially Conserved Axial-Vector Current in Photopion Production—M. L. Tapper. 171, 1561 (1968)

TARNÓCZI, T.
Magnetic Structures and Exchange Interactions in the Mn–Pt System—E. Krén, G. Kádár, L. Pál, J. Sólyom, P. Szabó, and T. Tarnóczi. 171, 574 (1968)

TAUSNER, M.
Field-Current Identities and Nucleon Radii—M. A. B. Bég, J. Bernstein, and M. Tausner. 173, 1523 (1968)

TAYLOR, Howard S.
Resonance Scattering of Slow Electrons from $H_2$ and CO Angular Distributions—H. Ehrhardt, L. Langhans, F. Linder, and H. S. Taylor. 173, 222 (1968)
Angular Dependence of Scattering Products in Electron-Molecule Resonant Excitation and in Dissociative Attachment—Thomas F. O'Malley and Howard S. Taylor. 176, 207 (1968)

TAYLOR, J., Jr.
Determination of the Neutron Polarization from the $^{13}C(^3He,n)^{15}O_{g.s.}$ Reaction from 2.9 to 3.9 MeV—Th. Stammbach, R. S. Thomason, J. Taylor, Jr., and R. L. Walter. 174, 1119 (1968)

TAYLOR, John G.
Does Lorentz-Invariance Imply Causality?—Michael M. Broido and John G. Taylor. 174, 1606 (1968)

TAYLOR, R. C.
Band Gap of Gallium Phosphide from 0 to 900°K and Light Emission from Diodes at High Temperatures—M. R. Lorenz, G. D. Pettit, and R. C. Taylor. 171, 876 (1968)

TAYLOR, R. Dean
Temperature-Dependent Isomer Shift and Anharmonic Binding of $Sn^{119}$ in $Nb_3Sn$ from Mössbauer-Effect Measurements—J. S. Shier and R. D. Taylor. 174, 346 (1968)
Correlation between Mössbauer Resonance Strength and Second-Order Doppler Shift: Estimate of Zero-Point Velocity—R. Dean Taylor and Paul P. Craig. 175, 782 (1968)

TEICH, M. C.
Two-Quantum Volume Photoelectric Effect in Sodium—M. C. Teich and G. J. Wolga. 171, 809 (1968)

TEITLER, S.
Separated Two-Component Equations for Spin-$\frac{1}{2}$ Particles Using Foldy-Wouthuysen-Type Transformations with an Application to the k·p Method in Solids—S. Teitler. 176, 1443 (1968)

TEMKIN, A.
Doubly Excited States of $H^-$ of High Principal Quantum Number: Implications for Electron-Atom Ionization—A. Temkin, A. K. Bhatia, and E. Sullivan. 176, 80 (1968)

TENG, M. K.
Raman Scattering in $KNO_3$ Phases I, II, and III—M. Balkanski, M. K. Teng, and M. Nusimovici. 176, 1098 (1968)

TERAMOTO, K.
Erratum: Electrical Resistivity and Thermoelectric Power of CuAu Alloy—K. Teramoto and M. Tachiki. [166, 656 (1968)] 172, 1002 (1968)

TERRELL, G. E.
$^{13}N$ Levels from $^{12}C(p,p)^{12}C$—E. M. Bernstein and G. E. Terrell. 173, 937 (1968)

TER VELD, L. K.
First Excited State of $^{36}S$—L. K. ter Veld and Th. W. van der Mark. 173, 1101 (1968)

TERZI, N.
Vibrational Structures Accompanying the Optic Transitions of Bound Electrons in Crystals—E. Mulazzi, G. F. Nardelli, and N. Terzi. 172, 847 (1968)

TEZER, Orhan
Hyperfine Structure of $^{67}Ga$ and $^{72}Ga$—Vernon J. Ehlers, Yurdanur Kabasakal, Howard A. Shugart, and Orhan Tezer. 176, 25 (1968)

THATCHER, F. C.
Nuclear Magnetic Resonance in Dilute Alloys of Indium-Lead and Indium-Tin—W. T. Anderson, Jr., F. C. Thatcher, and R. R. Hewitt. 171, 541 (1968)

THATCHER, R. C.
Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)

THEIMER, O.
Relativistic Corrections to the Light-Scattering Spectrum of a Plasma—O. Theimer and J. E. Sollid. 176, 198 (1968)

THEWS, Robert L.
High-Energy Polarized-Photon Reactions—Robert L. Thews. 175, 1749 (1968)

THIEBAUX, M. L.
Erratum: Reggeization of External Particles—M. L. Thiebaux. [170, 1244 (1968)] 173, 1806 (1968)

THIEBERGER, P.
Time Dependence of Mössbauer Scattered Radiation—P. Thieberger, J. A. Moragues, and A. W. Sunyar. 171, 425 (1968)

THOMAS, D. G.
Spin-Flip Raman Scattering in Cadmium Sulfide—D. G. Thomas and J. J. Hopfield. 175, 1020 (1968)

THOMAS, G. E.
$p$-Wave Resonances of $U^{238}$—L. M. Bollinger and G. E. Thomas. 171, 1293 (1968)

THOMAS, H.
Critical Behavior of the Pseudospin Model of Order–Disorder Type Ferroelectrics—E. Pytte and H. Thomas. 175, 610 (1968)

THOMAS, J. B.
Lifetimes of Levels in $^{12}C$, $^{13}C$, and $^{15}N$—F. Riess, P. Paul, J. B. Thomas, and S. S. Hanna. 176, 1140 (1968)

THOMAS, J. F., Jr.
Second- and Third-Order Elastic Constants of Alkali Metals—Tetsuro Suzuki, A. V. Granato, and J. F. Thomas, Jr. 175, 766 (1968)
Third-Order Elastic Constants of Aluminum—J. F. Thomas, Jr. 175, 955 (1968)

THOMAS, P.
Electron-Phonon Coupling in the Barriers of GaAs Schottky Diodes—P. Thomas and H. J. Queisser. 175, 983 (1968)

THOMAS, R. B., Jr.
Quantum Theory of Electrical Transport in a Magnetic Field. I—R. B. Thomas, Jr. 171, 827 (1968)

THOMAS, R. L.
Absolute de Haas–van Alphen Frequency Measurements in Potassium—R. L. Thomas and G. Turner. 176, 768 (1968)

THOMAS, T. D.
Light Nuclei Emitted in the Fission of $^{252}$Cf—G. M. Raisbeck and T. D. Thomas. 172, 1272 (1968)

THOMASON, R. S.
Determination of the Neutron Polarization from the $^{13}C(^3He,n)^{15}O_{g.s.}$ Reaction from 2.9 to 3.9 MeV—Th. Stammbach, R. S. Thomason, J. Taylor, Jr., and R. L. Walter. 174, 1119 (1968)

THOMMEN, K.
Energy and Orientation Dependence of Electron-Irradiation-Induced Damage in Undoped GaSb—K. Thommen. 174, 938 (1968)

THOMPSON, A. G.
Thermoreflectance in Semiconductors—E. Matatagui, A. G. Thompson, and Manuel Cardona. 176, 950 (1968)

THOMPSON, Colin J.
Determination of Critical Behavior in Lattice Statistics from Series Expansions. I.—Anthony J. Guttmann, Barry W. Ninham, and Colin J. Thompson. 172, 554 (1968)

THOMPSON, W. J.
Neutron Spectroscopic Factors from Isobaric Analog States—W. J. Thompson, J. L. Adams, and D. Robson. 173, 975 (1968)

THORNBER, N. S.
Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: General Features—P. Babu, S. Frautschi, and N. S. Thornber. 172, 1389 (1968)
Electromagnetic Perturbations on $\pi NN$ and $\pi NN^*$ Couplings in the Chew-Low Model: Detailed Calculation—N. S. Thornber. 172, 1395 (1968)
Inelastic Electron Scattering in the Symmetric Quark Model. II. Coulomb Potential—N. S. Thornber. 173, 1414 (1968)
$K^*(890)$ Photoproduction in the Regge-Pole Model—N. S. Thornber. 176, 1998 (1968)

THORPE, Arthur N.
Van Vleck Paramagnetism in Orthorhombic $TiO_2$ (Brookite)—Frank E. Senftle and Arthur N. Thorpe. 175, 1144 (1968)

TICKLE, Robert
Levels of $Bi^{205}$ Observed in the $Pb^{208}(He^3,\alpha)$ Reaction—John Bardwick and Robert Tickle. 171, 1305 (1968)

TIEMANN, J. J.
Erratum: Electron Tunneling in Metal-Semiconductor Barriers—J. W. Conley, C. B. Duke, G. D. Mahan, and J. J. Tiemann. [150, 466 (1966)] 174, 1082 (1968)

TIEN, P. K.
Nonlinear Theory of Ultrasonic Wave Amplification and Current Saturation in Piezoelectric Semiconductors—P. K. Tien. 171, 970 (1968)

TILFORD, C. R.
Specific Heats of Cu, GaAs, GaSb, InAs, and InSb from 1 to 30°K—T. C. Cetas, C. R. Tilford, and C. A. Swenson. 174, 835 (1968)

TILLEY, D. R.
Spins of Levels in $^{33}$P—C. E. Moss, R. V. Poore, N. R. Roberson, and D. R. Tilley. 174, 1333 (1968)

TINDLE, Graham L.
Daughters, Conspiracies, and Lorentz Symmetry—Khalil M. Bitar and Graham L. Tindle. 175, 1835 (1968)

TINKHAM, M.
The Mixed State in Superconducting Thin Films—F. E. Harper and M. Tinkham. 172, 441 (1968)
Coupled Motion of Vortices in Superposed Superconducting Films—R. Deltour and M. Tinkham. 174, 478 (1968)

TIPPINS, H. H.
Optical Spectrum and Zeeman Effect of $CaF_2:Eu^{2+}$—P. Kisliuk, H. H. Tippins, C. A. Moore, and S. A. Pollack. 171, 336 (1968)

TIVOL, W. F.
Proton-Proton Elastic Scattering between 6 and 10 MeV—R. J. Slobodrian, H. E. Conzett, E. Shield, and W. F. Tivol. 174, 1122 (1968)

TOBIN, R. A.
Inelastic Electron Scattering from $^{24}$Mg at 180°—L. W. Fagg, W. L. Bendel, R. A. Tobin, and H. F. Kaiser. 171, 1250 (1968)
Inelastic Electron Scattering from $^{26}$Mg at 180°.—W. L. Bendel, L. W. Fagg, R. A. Tobin, and H. F. Kaiser. 173, 1103 (1968)

TOBOCMAN, W.
Extended $R$-Matrix Theory of Nuclear Reactions—L. Garside and W. Tobocman. 173, 1047 (1968)
Calculation of the Lifetime of a Metastable System—L. Celenza and W. Tobocman. 174, 1115 (1968)

TOBUREN, L. H.
Measurement of High-Energy Charge-Transfer Cross Sections for Incident Protons and Atomic Hydrogen in Various Gases—L. H. Toburen, M. Y. Nakai, and R. A. Langley. 171, 114 (1968)

TOEPFER, Alan J.
$\Lambda$-$\Sigma$ Conversion and $\Lambda np$ Isospin-Zero Bound States—Alan J. Toepfer and L. H. Schick. 175, 1253 (1968)

TOLL, John S.
Scattering Model with Crossing Symmetry and Minimal Inelastic Effects—Franklin F. K. Cheung and John S. Toll. 173, 1791 (1968)

TOMPKINS, D.
1-BeV Electron Compton Scattering near 180°—B. Gittelman, W. C. Barber, W. Selove, D. Tompkins, and F. Forman. 171, 1388 (1968)

TONER, W. T.
Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)

TONG, B. Y.
Electronic Structure of One-Dimensional Binary Alloys—B. Y. Tong. 175, 710 (1968)

TONG, E.
Brillouin Scattering in Relaxing Liquids—A. B. Bhatia and E. Tong. 173, 231 (1968)

TOOTS, J.
Reflectance and $1/\epsilon$ Resonance of Beryllium in the Far Ultraviolet—J. Toots, H. A. Fowler, and L. Marton. 172, 670 (1968)

TORGERSON, David F.
Alpha Decay of the Isomers of $^{214}$Fr—David F. Torgerson, Richard A. Gough, and Ronald D. Macfarlane. 174, 1494 (1968)

TOSI, M. P.
Electron Correlations at Metallic Densities—K. S. Singwi, M. P. Tosi, R. H. Land, and A. Sjölander. 176, 589 (1968)

TOTH, G.
Theory of Localized Vibrations of Interstitial Atoms in bcc Lattices—G. Blaesser, J. Peretti, and G. Toth. 171, 665 (1968)

TOWNES, C. H.
Anti-Stokes Generation in Trapped Filaments of Light—C. A. Sacchi, C. H. Townes, and J. R. Lifsitz. 174, 439 (1968)

TRABERT, K.
Sum Rules for Weak $BB\pi$ Amplitudes—E. Fischbach and K. Trabert. 174, 1843 (1968)

TRAHIN, M.
Multiphoton Ionization of Atomic Hydrogen in the Ground State—Y. Gontier and M. Trahin. 172, 83 (1968)

TREFIL, J. S.
Anomalous Nuclear Photoproduction of $\phi$ Mesons—J. S. Trefil. 173, 1629 (1968)
TREILLE, D.
Positive Pion Photoproduction from Hydrogen for Incident Photon Energies 300–750 MeV—C. Betourne, J. C. Bizot, J. Perez-Y-Jorba, D. Treille, and W. Schmidt. 172, 1343 (1968)
TREIMAN, S. B.
Study of the Decays $K \to l\bar{l}$ and $K \to \pi l\bar{l}$—A. Pais and S. B. Treiman. 176, 1974 (1968)
TRIFTSHÄUSER, Werner
Mössbauer Effect of $I^{127}$ and $Te^{125}$ in Iodine, Tellurium, and Antimony Compounds—Peter Jung and Werner Triftshäuser. 175, 512 (1968)
TROST, W.
Elastic and Inelastic Scattering of $^3He$ by $^{12}C$, 12.0-18.0 MeV—H. T. Fortune, T. J. Gray, W. Trost, and N. R. Fletcher. 173, 1002 (1968)
TROUSDALE, W. L.
Magnetization Distribution in Magnetically Diluted Systems with Application to Iron-Palladium—T. A. Kitchens and W. L. Trousdale. 174, 606 (1968)
TROWER, W. P.
Two-Charged-Particle Final States of $K^-p$ Interactions at 2.63 and 2.70 GeV/$c$—J. R. Ficenec, H. A. Gordon, and W. P. Trower. 175, 1725 (1968)
TRUBATCH, S. L.
Resolution of the Runaway Problem for the Polaron—S. L. Trubatch. 174, 1555 (1968)
TRUBY, Frank K.
Dissociative Electron Attachment in $I_2$ Vapor at 295°K—Frank K. Truby. 172, 24 (1968)
TRUEMAN, T. L.
Kinematic Singularities and Constraints of Helicity Amplitudes—T. L. Trueman. 173, 1684 (1968)
TRUHLAR, Donald G.
Rearrangement Collisions: Effect of Core Terms, Nonorthogonality, and Conservation of Particle Flux on Approximate Theories—Donald G. Truhlar, David C. Cartwright, and Aron Kuppermann. 175, 113 (1968)
TRUJILLO, S. M.
Erratum: Study of $H_2^+ + H_2 \to H_3^+ + H$ Using Merging Beams—R. H. Neynaber and S. M. Trujillo. [167, 63 (1968)] 171, 282 (1968)
TRUONG, Tran N.
Pion Electromagnetic Form Factor—Tran N. Truong, R. Vinh Mau, and Pham xuan Yem. 172, 1645 (1968)
TSANG, J. C.
Concentration Quenching of Luminescence by Donors or Acceptors in Gallium Phosphide and the Impurity-Band Auger Model—J. C. Tsang, P. J. Dean, and P. T. Landsberg. 173, 814 (1968)
TSCHALÄR, C.
Mean Excitation Potential of Light Compounds—C. Tschalär and Hans Bichsel. 175, 476 (1968)
TSENG, P. K.
Mössbauer Measurements with $K^{40}$—P. K. Tseng, S. L. Ruby, and D. H. Vincent. 172, 249 (1968)
TSU, R.
Optical and Electrical Properties and Band Structure of GeTe and SnTe—R. Tsu, W. E. Howard, and L. Esaki. 172, 779 (1968)
TTERLIKKIS, L.
Theoretical Analysis of the Hyperfine Structure of Alkali Atoms—L. Tterlikkis, S. D. Mahanti, and T. P. Das. 176, 10 (1968)
TUBIS, Arnold
Modified Dispersion Relations and $\pi\pi$ Scattering—David J. George, Barbara Hale, and Arnold Tubis. 172, 1740 (1968)
Application of Modified Dispersion Relations to the Forward $KN$ Crossing-Even Scattering Amplitude—David J. George and Arnold Tubis. 174, 1871 (1968)
Regge Parameters in Crossing-Even $KN$ Scattering—David J. George and Arnold Tubis. 174, 1875 (1968)
Modified Phase Representation and Effects of Inelasticity in $N/D$ Calculation of $p$-Wave Pion-Pion Scattering—Barbara Hale and Arnold Tubis. 174, 2074 (1968)
TUCKER, Thomas C.
Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions—Thomas C. Tucker, Louis D. Roberts, C. W. Nestor, Jr., Thomas A. Carlson, and F. B. Malik. 174, 118 (1968)
TUFTE, O. N.
Magnetoresistance in Semiconducting Strontium Titanate—O. N. Tufte and E. L. Stelzer. 173, 775 (1968)
TULLY, John C.
Angular Distribution of Molecular Photoelectrons—John C. Tully, R. Stephen Berry and Bryan J. Dalton. 176, 95 (1968)
TUNG, Wu-Ki
Invariant Amplitudes for Photon Processes—W. A. Bardeen and Wu-Ki Tung. 173, 1423 (1968)
Compton Scattering by Spin-One Particles—Wu-Ki Tung. 176, 2127 (1968)
TURNER, G.
Absolute de Haas–van Alphen Frequency Measurements in Potassium—R. L. Thomas and G. Turner. 176, 768 (1968)
TURNER, J. E.
Ground-State Energy Eigenvalues and Eigenfunctions for an Electron in an Electric-Dipole Field—J. E. Turner, V. E. Anderson, and Kenneth Fox. 174, 81 (1968)
TWITTY, J.
Low-Energy $\Lambda$-Proton Elastic Scattering—B. Sechi-Zorn, B. Kehoe, J. Twitty, and R. A. Burnstein. 175, 1735 (1968)
TZOAR, N.
Erratum: Kinetic Equation for Drifted Electron Plasma—N. Tzoar. [162, 123 (1967)] 172, 241 (1968)
Light Scattering from a Plasma in a Magnetic Field—P. M. Platzman, P. A. Wolff, and N. Tzoar. 174, 489 (1968)
ÜBERALL, H.
Electroexcitation of the Giant Resonance in $^{12}C$—Francis J. Kelly and H. Überall. 175, 1235 (1968)
UEDA, T.
Realistic $N$-$N$ One-Boson-Exchange Potentials—T. Ueda and A. E. S. Green. 174, 1304 (1968)
UEDA, Yoshiaki
Hard-Kaon Processes and the Spectral-Function Sum Rules—Yoshiaki Ueda. 174, 2082 (1968)
UEHLING, Edwin A.
Nuclear-Spin-Diffusion Relaxation to a Finite Density of Paramagnetic Impurity Ions—Eiichi Fukushima and Edwin A. Uehling. 173, 366 (1968)
Determination of the Electric-Field-Gradient Tensor at the Arsenic Site in $KH_2AsO_4$ by Proton Relaxation Measurements—Wendland Beezhold and Edwin A. Uehling. 175, 624 (1968)
ULLAH, Nazakat
Overlapping Compound-Nucleus Resonances—Nazakat Ullah. 173, 971 (1968)

UNTERWALD, Frank C.
Adjusting Poles and Zeros of Dielectric Dispersion to Fit Reststrahlen of $PrCl_3$ and $LaCl_3$—Dwight W. Berreman and Frank C. Unterwald. 174, 791 (1968)

URE, R. W., Jr.
de Haas–van Alphen Effect in n-Type $Bi_2Te_3$—R. B. Mallinson, J. A. Rayne, and R. W. Ure, Jr. 175, 1049 (1968)

VAIDYA, P. C.
Nonstatic Analogs of Schwarzschild's Interior Solution in General Relativity—P. C. Vaidya. 174, 1615 (1968)

VAISHYA, J. S.
Structure-Dependent Axial-Vector Form Factor in Charged-Pion Radiative Decay—J. S. Vaishya. 173, 1757 (1968)
Momentum-Dependent $K_{e4}$-Decay Form Factors—Ranabir Dutt, K. C. Gupta, and J. S. Vaishya. 175, 1884 (1968)
Virtual-Photon–Pion Scattering, Hard-Pion Current Algebra, and Dispersion Relations—K. C. Gupta and J. S. Vaishya. 176, 2125 (1968)

VAJDA, P.
Stopping Power of the Elements $Z=20$ Through $Z=30$ for 5–12-MeV Protons and Deuterons—H. H. Andersen, C. C. Hanke, H. Simonsen, H. Sørensen, and P. Vajda. 175, 389 (1968)

VALLI, Kalevi
New Isotopes of Thorium Studied with an Improved Helium-Jet Recoil Transport Apparatus—Kalevi Valli and Earl K. Hyde. 176, 1377 (1968)

VAN, J. Tran Thanh
Factorization and Constraints in Regge-Pole Theory—A. Capella, A. P. Contogouris, and J. Tran Thanh Van. 175, 1892 (1968)

VAN BAARLE, C.
Lattice Heat Conductivity in Annealed and Quenched Gold-Platinum Alloys—C. van Baarle and R. P. Huebener. 172, 699 (1968)

VANDER LUGT, K. L
Conversion of $F_3^+$ Centers and Destruction of $R$ Centers in LiF with $R$ Light—K. L. Vander Lugt and Y. W. Kim. 171, 1096 (1968)

VAN DER MARK, Th. W.
First Excited State of $^{35}S$—L. K. ter Veld and Th. W. van der Mark. 173, 1101 (1968)

VANDER VELDE, J. C.
Extracting the Phase of Scattering Amplitudes by Means of the Glauber Formula—J. C. Vander Velde. 173, 1544 (1968)

VANFLEET, H. B.
Mössbauer-Effect Measurements in Iron at High Pressures—W. H. Southwell, D. L. Decker, and H. B. Vanfleet. 171, 354 (1968)

VAN GINNEKEN, A.
Moment of Inertia in Light Nuclei—S. Das Gupta and A. Van Ginneken. 174, 1316 (1968)

VAN HISE, J. R.
Alpha Decay of $^{242}Am$—J. R. Van Hise and D. Engelkemeir. 171, 1325 (1968)

VAN KAMPEN, N. G.
Relativistic Thermodynamics of Moving Systems—N. G. van Kampen. 173, 295 (1968)

VAN LEEUWEN, J.
Phase Separation in Isotopic Fermi-Bose Mixtures—J. M. J. van Leeuwen and E. G. D. Cohen. 176, 385 (1968)

VANNOTTI, L. E.
Paramagnetic-Resonance Spectra of $S^-$ Trapped in Alkali Halide Crystals—L. E. Vannotti and J. R. Morton. 174, 448 (1968)

VAN OERS, W. T. H.
Angular Distribution of the $d(\vec{p},n)2p$ Reaction at 45.5 MeV—Demetrius J. Margaziotis, Byron T. Wright, and W. T. H. van Oers. 171, 1170 (1968)

VAN OOSTRUM, K. J.
Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)

VAN PATTER, D. M.
Energy Levels in $^{89}Y$—P. F. Hinrichsen, S. M. Shafroth, and D. M. Van Patter. 172, 1134 (1968)

VANT-HULL, Lorin L.
Experimental Upper Limit on the Magnetic Monopole Moment of Electrons, Protons, and Neutrons, Utilizing a Superconducting Quantum Interferometer—Lorin L. Vant-Hull. 173, 1412 (1968)

VAN UITERT, L. G.
Investigation of Magnetic Interactions in $TbAlO_3$ by Optical Spectroscopy—S. Hüfner, L. Holmes, F. Varsanyi, and L. G. Van Uitert. 171, 507 (1968)

VAN VLECK, J. H.
Origin of "Hidden Momentum Forces" on Magnets—Sidney Coleman and J. H. Van Vleck. 171, 1370 (1968)

VAN VLIET, K. M.
Noise Properties of n-Type Gold-Doped Silicon—M. B. Colligan and K. M. van Vliet. 171, 881 (1968)

VAN ZANDT, L. L.
Plasmons and Zeroth Sound in the Electron Gas—L. L. Van Zandt. 172, 372 (1968)

VARMA, V. S.
Current Algebra, Crossing Symmetry, and Unitarity for s-Wave $\pi\pi$ Scattering—K. Datta, K. C. Gupta, and V. S. Varma. 173, 1549 (1968)

VARNEY, R. N.
Equilibrium Constant and Rates for the Reversible Reaction $N_4^+ = N_2^+ + N_2$—R. N. Varney. 174, 165 (1968)
Metastable Atoms and Molecules. III. Metastable Impacts on Surfaces with Various Work Functions—R. N. Varney. 175, 98 (1968)

VARSANYI, F.
Investigation of Magnetic Interactions in $TbAlO_3$ by Optical Spectroscopy—S. Hüfner, L. Holmes, F. Varsanyi, and L. G. Van Uitert. 171, 507 (1968)

VARSHNI, Y. P.
Angular Forces in the Lattice Dynamics of Face-Centered Cubic Metals. II—Y. P. Varshni and P. S. Yuen. 174, 766 (1968)

VASAVADA, Kashyap V.
Erratum: Perturbed Bound-State Poles in Potential Scattering. II—Y. S. Kim and Kashyap V. Vasavada. [150, 1236 (1966)] 172, 1849 (1968)
Continuous-Moment Sum Rules and Pion Conspiracy in Photoproduction—K. Raman and Kashyap V. Vasavada. 175, 2191 (1968)
Erratum: Solutions of the Bethe-Salpeter and $N/D$ Equations—K. V. Vasavada. [165, 1830 (1968)] 176, 2167 (1968)

VAUGHN, Mark H.
Conspirators and Daughters in Unequal-Mass, Nonzero-Spin Scattering—Matthew A. Jacobs and Mark H. Vaughn. 172, 1677 (1968)

VAWTER, Richard
Effects of Finite Boundaries on a One-Dimensional Harmonic Oscillator—Richard Vawter. 174, 749 (1968)

VAZQUEZ, F.
Electroreflectance Measurements on $Mg_2Si$, $Mg_2Ge$, and $Mg_2Sn$—F. Vazquez, Richard A. Forman, and Manuel Cardona. 176, 905 (1968)

VELICKY, B.
Single-Site Approximations in the Electronic Theory of Simple Binary Alloys—B. Velicky, S. Kirkpatrick, and H. Ehrenreich. 175, 747 (1968)

VENEZIANO, G.
Bootstrap of Meson Trajectories from Superconvergence—M. Ademollo, H. R. Rubinstein, G. Veneziano, and M. A. Virasoro. 176, 1904 (1968)
Meson Bootstraps for Unnatural-Parity States—M. Bishari, H. R. Rubinstein, A. Schwimmer, and G. Veneziano. 176, 1926 (1968)

VENTURI, Giovanni
Structure of the Nonleptonic Weak Interactions of Mesons—Giovanni Venturi. 174, 2154 (1968)

VERHEY, L. J.
Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)

VERLEUR, Hans W.
Optical Properties of $VO_2$ between 0.25 and 5 eV—Hans W. Verleur, A. S. Barker, Jr., and C. N. Berglund. 172, 788 (1968)

VERMA, G. S.
Phonon Conductivity and Acoustic Attenuation in Si—R. P. Singh and G. S. Verma. 171, 838 (1968)
Erratum: Role of Longitudinal and Transverse Phonons in Lattice Thermal Conductivity of GaAs and InSb—C. M. Bhandari and G. S. Verma. [140, A2101 (1965)] 176, 1112 (1968)

VERSCHUEREN, M.
Effect of an External Radiation on the Energy Levels of an Electron System—B. L. Jones and M. Verschueren. 176, 42 (1968)

VICTOR, G. A.
Nonadiabatic Long-Range Forces—A. Dalgarno, G. W. F. Drake, and G. A. Victor. 176, 194 (1968)

VIDAL, Jose G.
Study of the Two-Body Force through the $(He^3,t)$ Charge-Exchange Reaction on $O^{17}$ and $O^{18}$—Luisa F. Hansen, Marion L. Stelts, Jose G. Vidal, J. J. Wesolowski, and V. A. Madsen. 174, 1155 (1968)

VINCENT, C. M.
Gell-Mann–Goldberger Relation for Reactions of the Form $(d,pn)$—C. M. Vincent. 175, 1309 (1968)

VINCENT, D. H.
Mössbauer Measurements with $K^{40}$—P. K. Tseng, S. L. Ruby, and D. H. Vincent. 172, 249 (1968)

VINH MAU, R.
Pion Electromagnetic Form Factor—Tran N. Truong, R. Vinh Mau, and Pham xuan Yem. 172, 1645 (1968)

VIRASORO, M. A.
Bootstrap of Meson Trajectories from Superconvergence—M. Ademollo, H. R. Rubinstein, G. Veneziano, and M. A. Virasoro. 176, 1904 (1968)

VISSCHER, William M.
Dynamics of Disordered Harmonic Lattices. III. Normal-Mode Spectra for Abnormal Arrays—Daniel N. Payton, III, and William M. Visscher. 175, 1201 (1968)

VISWANATHAN, C. R.
Spin-Lattice Relaxation-Time Measurements on $Er^{3+}$-Doped Lanthanum Ethylsulfate—C. R. Viswanathan and G. Kaelin. 171, 992 (1968)
Low-Temperature Specific Heat of Face-Centered Cubic Ni-Co Alloys—James C. Ho and R. Viswanathan. 172, 705 (1968)

VOLTOLINI, C.
Angular Correlations and Distributions in $\bar{p}p$ Annihilation into Eight and Nine Pions at 5.7 GeV/$c$—A. Fridman, G. Maurer, A. Michalon, J. Oudet, R. Straub, C. Voltolini, and P. Cüer. 176, 1595 (1968)

VON BRENTANO, P.
Determination of Total Widths and Resonance Energies of the Single-Particle Analog Resonances in $^{209}Bi$—W. R. Wharton, P. von Brentano, W. K. Dawson, and Patrick Richard. 176, 1424 (1968)

VON GOELER, S.
Measurement of Volume Recombination Coefficients in Highly Ionized Alkali Plasmas—S. von Goeler, R. W. Motley, and R. Ellis. 172, 162 (1968)

VON HIPPEL, Frank
Zero-Parameter Model of the $N$-$N$ Potential—Hirotaka Sugawara and Frank von Hippel. 172, 1764 (1968)

VOOK, Frederick L.
Partition of the Average Energy Deposited in Germanium as a Function of Incident Neutron Energy—Allan R. Sattler and Frederick L. Vook. 173, 435 (1968)
Channeling in Zinc-Blende Lattices: Energy-Loss Studies for Hydrogen and Helium Ions in InAs, GaSb, AlSb, and InSb—Allan R. Sattler and Frederick L. Vook. 175, 526 (1968)

VOSS, P.
Stationary High-Field Domains in the Range of Negative Differential Conductivity in CdS Single Crystals—K. W. Böer and P. Voss. 171, 899 (1968)

VREDEVOE, Lawrence A.
Magnetic Scattering of Electrons from Crystals and Polarization of the Scattered Beam—Lawrence A. Vredevoe and Roger E. De Wames. 176, 684 (1968)

VUJIČIĆ, Milan
Antilinear Operators in Hartree-Bogolyubov Theory. I—Fedor Herbut and Milan Vujičić. 172, 1031 (1968)

WADA, Walter W.
$\kappa$-Meson Mass and Weak-Decay Parameters from a Study of $K_{l3}$ Form Factors—Jacob E. Mackey, J. Michael McKisic, David M. Scott, and Walter W. Wada. 172, 1590 (1968)

WADDINGTON, C. J.
Very Heavy Nuclei in the Primary Cosmic Radiation. I. Observations on the Energy Spectrum—P. S. Freier and C. J. Waddington. 175, 1641 (1968)
Very Heavy Nuclei in the Primary Cosmic Radiation. II. Interpretation of the Energy Spectra—C. J. Waddington and P. S. Freier. 175, 1649 (1968)

WAGHMARE, Y. R.
Effective Interaction for Light and Intermediate Nuclei—K. P. Joshi, G. K. Mehta, and Y. R. Waghmare. 176, 1154 (1968)

WAGNER, H.
Coupling of Density and Spin Fluctuations to Quasiparticles in a Fermi Liquid—D. J. Amit, J. W. Kane, and H. Wagner. 175, 313 (1968)
Logarithmic Terms in the Specific Heat of a Normal Fermi Liquid—D. J. Amit, J. W. Kane, and H. Wagner. 175, 326 (1968)

WAGNER, W. G.
Large-Scale Self-Trapping of Optical Beams in the Paraxial Ray Approximation—W. G. Wagner, H. A. Haus, and J. H. Marburger. 175, 256 (1968)

WAGSTAFF, R. L.
$K^-p$ Elastic Scattering at 4.6 GeV/$c$—L. S. Schroeder, R. A. Leacock, R. L. Wagstaff, and W. J. Kernan. 176, 1648 (1968)
WAHLQUIST, Hugo D.
Interior Solution for a Finite Rotating Body of Perfect Fluid —Hugo D. Wahlquist. 172, 1291 (1968)
WALKER, Charles T.
Experimental and Theoretical Study of the Scattering of Phonons by $U$ Centers in Alkali Halide Crystals—Lee G. Radosevich and Charles T. Walker. 171, 1004 (1968)
WALKER, G. E.
Muon-Capture and Photon-Absorption Calculations in a Configuration-Mixing Model for $O^{16}$—G. E. Walker. 174, 1290 (1968)
WALKER, J. K.
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
WALKER, James F.
Analyticity and Broken $SL(2, C)$ Symmetry for Regge Families—P. K. Kuo and James F. Walker. 175, 1794 (1968)
WALKER, M. B.
Absence of Magnetic Ordering in One and Two Dimensions in a Many-Band Model for Interacting Electrons in a Metal —M. B. Walker and Th. W. Ruijgrok. 171, 513 (1968)
Theory of Paramagnetic Impurity Spin Resonance in Metals—M. B. Walker. 176, 432 (1968)
WALLACE, Duane C.
Qualitative Temperature and Volume Dependence of the Thermal Expansion Coefficient of Solids—Duane C. Wallace. 176, 827 (1968)
Pseudopotential Calculation of the Thermal Expansion Coefficient of Sodium and Potassium—Duane C. Wallace. 176, 832 (1968)
WALSH, W. M., Jr.
Study of the Radio-Frequency Size Effect in Potassium—P. S. Peercy, W. M. Walsh, Jr., L. W. Rupp, Jr., and P. H. Schmidt. 171, 713 (1968)
Fermi-Liquid Effects on High-Frequency Wave Propagation in Simple Metals—P. M. Platzman, W. M. Walsh, Jr., and E-Ni Foo. 172, 689 (1968)
WALTER, R. L.
Determination of the Neutron Polarization from the $^{13}C(^3He,n)^{15}O_{g.s.}$ Reaction from 2.9 to 3.9 MeV—Th. Stammbach, R. S. Thomason, J. Taylor, Jr., and R. L. Walter. 174, 1119 (1968)
WALTERS, G. K.
Diffusion of He($2^3S_1$) in Helium Gas; $2\,^3S_1 - 1\,^1S_0$ Interaction Potentials at Long Range—W. A. Fitzsimmons, N. F. Lane, and G. K. Walters. 174, 193 (1968)
WALTHER, K.
Anisotropy of Magnetoacoustic Attenuation and Deformation Potential in Bismuth—K. Walther. 174, 782 (1968)
WALTON, R. B.
Measurements of the $^{63}Cu(\gamma,n)$ and $(\gamma,2n)$ Cross Sections—R. E. Sund, M. P. Baker, L. A. Kull, and R. B. Walton. 176, 1366 (1968)
WANG, Chen-Show
Propagation of an Intense Light Beam in a Nonlinear Medium —Chen-Show Wang. 173, 908 (1968)
WANG, E. Y.
Orientation Dependence of Ultrasonic Attenuation in Copper —E. Y. Wang, R. J. Kolouch, and K. A. McCarthy. 175, 723 (1968)
WANG, K. H.
Range and $dE/dx$ of C, N, O, F, and Ne in Be and C from 500 keV to 2 MeV—W. K. Chu, P. D. Bourland, K. H. Wang, and D. Powers. 175, 342 (1968)
WANG, Yung-Li
Collective Excitations and Magnetic Ordering in Materials with Singlet Crystal-Field Ground State—Yung-Li Wang and Bernard R. Cooper. 172, 539 (1968)
Dynamic Susceptibility of Magnetic Ions in Metals—Yung-Li Wang and D. J. Scalapino. 175, 734 (1968)
WARBURTON, E. K.
$E2$ and $M1$ Matrix Elements in $B^{10}$—E. K. Warburton, J. W. Olness, S. D. Bloom, and A. R. Poletti. 171, 1178 (1968)
Nuclear Structure of $Na^{22}$. V. Doppler-Shift Attenuation Measurements—P. Paul, J. W. Olness, and E. K. Warburton. 173, 1063 (1968)
Beta Decay of $N^{16}$ to the 6.05-MeV State of $O^{16}$—E. K. Warburton, W. R. Harris, and D. E. Alburger. 175, 1275 (1968)
$Ne^{22}(t,p\gamma)Ne^{24}$ Angular Correlation Study—J. A. Becker, L. F. Chase, Jr., R. E. McDonald, and E. K. Warburton. 176, 1310 (1968)
WARD, C. E. W.
$\bar{K}^0$ and $\Lambda^0$ Production in $K^- + p$ Interactions at 7.7 GeV/$c$—A. Buffington and C. E. W. Ward. 176, 1621 (1968)
Charge-Exchange $K^- + p \to \bar{K}^0 + n$ at 7.7 GeV/$c$—A. Buffington, D. H. Frisch, and C. E. W. Ward. 176, 1628 (1968)
WARD, Wirt C.
Additive Coloration of Alkaline-Earth Chalcogenides—Eugene B. Hensley, Wirt C. Ward, Bruce P. Johnson, and Roger L. Kroes. 175, 1227 (1968)
Additive Coloration of Calcium Oxide—Wirt C. Ward and Eugene B. Hensley. 175, 1230 (1968)
WARKE, Chindhu
Binding Energies of Open-Shell Nuclei—Maria Dworzecka and Chindhu S. Warke. 175, 1346 (1968)
WARNOCK, Robert L.
Erratum: Existence Proof by a Fixed-Point Theorem for Solutions of the Low Equation—Robert L. Warnock. [170, 1323 (1968)] 174, 2169 (1968)
WARTER, Peter J., Jr.
Field-Controlled Photogeneration and Free-Carrier Transport in Amorphous Selenium Films—Mark D. Tabak and Peter J. Warter, Jr. 173, 899 (1968)
WASSON, O. A.
$Au^{197}(n,\gamma)Au^{198}$ Reaction Mechanism—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 173, 1170 (1968)
Resonant and Nonresonant Capture of Slow Neutrons in $Tm^{169}(n,\gamma)Tm^{170}$—M. A. Lone, R. E. Chrien, O. A. Wasson, M. Beer, M. R. Bhat, and H. R. Muether. 174, 1512 (1968)
Direct Neutron Capture in $Co^{59}(n,\gamma)Co^{60}$—O. A. Wasson, R. E. Chrien, M. R. Bhat, M. A. Lone, and M. Beer. 176, 1314 (1968)
WATKINS, G. D.
Defects in Irradiated Silicon: Electron Paramagnetic Resonance and Electron-Nuclear Double Resonance of the Arsenic- and Antimony-Vacancy Pairs—Edward L. Elkin and G. D. Watkins. 174, 881 (1968)
WATSON, H. L.
Splitting, Mixing, and Small Perturbations in $SU(3)$ Multiplets of Vector Mesons—L. F. Cook and H. L. Watson. 174, 2113 (1968)
WATSON, Kenneth M.
Electronic Transitions in Slow Collisions of Atoms and Molecules. I—Joseph C. Y. Chen and Kenneth M. Watson. 174, 152 (1968)

WATSON, R. E.
Solute Knight Shifts in Noble Metals—Lawrence H. Bennett, R. W. Mebs, and R. E. Watson. 171, 611 (1968)
WATT, L. A. K.
Calculation of the Deformation Energy of a Schottky Defect in Germanium—C. J. Hwang and L. A. K. Watt. 171, 958 (1968)
WATTENBERG, A.
Upper Limit on the Decay Rate $K_L^0 \to \pi^+\pi^-\gamma$—R. C. Thatcher, A. Abashian, R. J. Abrams, D. W. Carpenter, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, L. J. Verhey, and A. Wattenberg. 174, 1674 (1968)
Muon Polarization in $K_{\mu 3}^0$-Meson Decay—R. J. Abrams, A. Abashian, R. E. Mischke, B. M. K. Nefkens, J. H. Smith, R. C. Thatcher, L. J. Verhey, and A. Wattenberg. 176, 1603 (1968)
WATTS, R. K.
Paramagnetic-Resonance Studies of Rare-Earth Impurities in II-VI Compounds—R. K. Watts and W. C. Holton. 173, 417 (1968)
WAUGH, J. S.
Coherent Averaging Effects in Magnetic Resonance—U. Haeberlen and J. S. Waugh. 175, 453 (1968)
WAYLAND, J. R.
Origin of Primary Cosmic Radiation and Its Antiproton Component—J. R. Wayland and Theodore Bowen. 171, 1376 (1968)
Two-Temperature Statistical Model of Particle Spectra—J. R. Wayland. 175, 2106 (1968)
WEAVER, H. T.
Effects of Electron–Electron Interactions on Nuclear Spin-Lattice Relaxation Rates and Knight Shifts in Alkali and Noble Metals—Albert Narath and H. T. Weaver. 175, 373 (1968)
WEBB, Maurice B.
Multiphonon Scattering of Low-Energy Electrons—Robert F. Barnes, Max G. Lagally, and Maurice B. Webb. 171, 627 (1968)
WEBER, M. J.
Radiative and Multiphonon Relaxation of Rare-Earth Ions in $Y_2O_3$—M. J. Weber. 171, 283 (1968)
WEBER, T.
Microscopic Theory of Effective Operators for Electromagnetic Interactions in Nuclei—M. Gmitro, A. Rimini, J. Sawicki, and T. Weber. 175, 1243 (1968)
WECKERMANN, B.
Disappearance of a Vibrational Mode in the Ferroelectric Phase Transition of $KH_2PO_4$—Ch. Schenk, E. Wiener, B. Weckermann, and W. Kley. 172, 576 (1968)
WEGENER, Horst H. F.
Coulomb-Recoil-Implantation Mössbauer Experiments with $^{73}$Ge—Gordon Czjzek, J. L. C. Ford, Jr., John C. Love, Felix E. Obenshain, and Horst H. F. Wegener. 174, 331 (1968)
WEIL, J. L.
Proton-Induced Reactions on $^{40}$Ar and Analogs of $^{41}$Ar Levels—H. L. Scott, W. Galati, J. L. Weil, and M. T. McEllistrem. 172, 1139 (1968)
WEILER, Margaret H.
Theory of Multiphoton Magnetoabsorption in Semiconductors—Margaret H. Weiler, M. Reine, and Benjamin Lax. 171, 949 (1968)
WEINBERG, Steven
Structure of Three-Point Functions from $SU(3) \otimes SU(3)$ Algebra—Ira S. Gerstein, Howard J. Schnitzer, and Steven Weinberg. 175, 1873 (1968)
WEINERT, R. W.
Knight Shift in Single-Crystal Mercury—R. W. Weinert and R. T. Schumacher. 172, 711 (1968)
WEIS, J. H.
Conspiracy and Counterconspiracy in Equal-Mass Scattering—J. H. Weis. 176, 1822 (1968)
WEISBERGER, William I.
Ultraviolet Divergences in Radiative Corrections to Weak Decays—Giuliano Preparata and William I. Weisberger 175, 1965 (1968)
WEISS, A. W.
Regularities in Atomic Oscillator Strengths—W. L. Wiese and A. W. Weiss. 175, 50 (1968)
WEISS, H. V.
Identification of 5.3-sec $^{118}$Ag as a Product of $^{238}$U Fission—H. V. Weiss, J. M. Fresco, and W. L. Reichert. 172, 1266 (1968)
Identification and Yield of 5.0-sec $^{117}$Pd in the Thermal-Neutron Fission of $^{238}$U—H. V. Weiss, J. L. Elzie, and J. M. Fresco. 172, 1269 (1968)
WEISS, Richard J.
X-Ray Determination of Electron Momenta in Li, Be, B, Na, Mg, Al, and LiF—Walter C. Phillips and R. J. Weiss. 171, 790 (1968)
X-Ray Determination of the Electron Momentum Density in Diamond, Graphite, and Carbon Black—Richard J. Weiss and Walter C. Phillips. 176, 900 (1968)
WEISSKOPF, M. C.
Electric Dipole Moments of Alkali Atoms. A Limit to the Electric Dipole Moment of the Free Electron—J. P. Carrico, E. Lipworth, P. G. H. Sandars, T. S. Stein, and M. C. Weisskopf. 174, 125 (1968)
WELLER, Charles S.
Recombination, Attachment, and Ambipolar Diffusion of Electrons in Photo-Ionized NO Afterglows—Charles S. Weller and Manfred A. Biondi. 172, 198 (1968)
WELLING, Daniel J.
Relation of Charged-$K$ Decay to $CP$ Violation—Robert M. Delaney and Daniel J. Welling. 176, 1841 (1968)
WELLS, John C., Jr.
Ionic Transport in Potassium Chloride—Robert G. Fuller, Charles L. Marquardt, Michael H. Reilly, and John C. Wells, Jr. 176, 1036 (1968)
WELSH, L. B.
Ground State of the Magnetic Impurity Problem; Nuclear-Magnetic-Resonance Studies of Dilute Copper Alloys—A. J. Heeger, L. B. Welsh, M. A. Jensen, and G. Gladstone. 172, 302 (1968)
WEMPLE, S. H.
Raman Spectrum of Single-Domain $BaTiO_3$—M. DiDomenico, Jr., S. H. Wemple, S. P. S. Porto, and R. P. Bauman. 174, 522 (1968)
WERNICK, J. H.
Mössbauer Effect in Europium Alloys—S. Hüfner and J. H. Wernick. 173, 448 (1968)
WERNTZ, Carl
$A^{-1/6}$ Dependence of Giant Dipole Energies—Richard Bach and Carl Werntz. 173, 958 (1968)
WERT, C. A.
Isotope Effect for Diffusion of Iron in Vanadium—M. G. Coleman, C. A. Wert, and R. F. Peart. 175, 788 (1968)
WERTHAMER, N. R.
Erratum: Towards a Quantum Many-Body Theory of Lattice Dynamics. II. Collective Fluctuation Approximation—N. S. Gillis and N. R. Werthamer. [167, 607 (1968)] 173, 918 (1968)

Calculation of the Self-Consistent Phonon Spectrum of hcp $He^4$—N. S. Gillis, T. R. Koehler, and N. R. Werthamer. 175, 1110 (1968)

WERTHEIM, G. K.
Magnetic Properties of the Planar Antiferromagnet $Rb_2FeF_4$—G. K. Wertheim, H. J. Guggenheim, H. J. Levinstein, D. N. E. Buchanan, and R. C. Sherwood. 173, 614 (1968)

WESOLOWSKI, J. J.
Two-Particle, Two-Hole States in $^{40}K$ from the Study of the $^{40}Ar(^3He,^3H)^{40}K$ Reaction—J. J. Wesolowski, Luisa F. Hansen, and M. L. Stelts. 172, 1072 (1968)

Study of the Two-Body Force through the $(He^3,t)$ Charge-Exchange Reaction on $O^{17}$ and $O^{18}$—Luisa F. Hansen, Marion L. Stelts, Jose G. Vidal, J. J. Wesolowski, and V. A. Madsen. 174, 1155 (1968)

WEST, Geoffrey B.
Coulomb Interference in High-Energy Scattering—Geoffrey B. West and D. R. Yennie. 172, 1413 (1968)

Bjorken Limit and Pole Dominance. I. The $\omega\rho\pi$ System and the Algebra of Fields—Stanley G. Brown and Geoffrey B. West. 174, 1777 (1968)

Bjorken Limit and Pole Dominance. II. Virtual $\pi\rho$ Scattering—Stanley G. Brown and Geoffrey B. West. 174, 1786 (1968)

WEST, R. W.
Collective Effects in the $P^{31}(He^3,p)S^{33}$ Reaction—R. S. Cox, R. W. West, and R. J. Ascuitto. 175, 1419 (1968)

WEYERS, J.
Statistical Model for High-Energy Reactions—L. L. Foldy, H. Kottler, D. R. Speiser, and J. Weyers. 173, 1517 (1968)

WEYMANN, Helmut D.
Elastic and Thermal Waves in Solids at Hypersonic Frequencies—Helmut D. Weymann. 176, 838 (1968)

WHARTON, W. R.
Determination of Total Widths and Resonance Energies of the Single-Particle Analog Resonances in $^{209}Bi$—W. R. Wharton, P. von Brentano, W. K. Dawson, and Patrick Richard. 176, 1424 (1968)

WHIPPEY, P. W.
Investigations of $4f\leftrightarrow5d$ Transitions of $Ce^{+3}$ in $CaF_2$—M. Schlesinger and P. W. Whippey. 171, 361 (1968)

WHITE, C. W.
Determination of $g$-Factor Ratios for Free $Rb^{85}$ and $Rb^{87}$ Atoms—C. W. White, W. M. Hughes, G. S. Hayne, and H. G. Robinson. 174, 23 (1968)

WHITE, Robert M.
Magnon Corrections to the Effective Mass of an Electron in a Magnetic Semiconductor—Robert M. White and Roy B. Woolsey. 176, 908 (1968)

WIDOM, Allan
Superfluid Phase Transitions in One and Two Dimensions—Allan Widom. 176, 254 (1968)

WIECKOWICZ, R. P.
$\pi^-p$ Elastic Scattering at 2.26 GeV/$c$—B. G. Reynolds, J. D. Kimel, J. R. Albright, R. H. Bradley, E. B. Brucker, W. C. Harrison, B. C. Harms, J. E. Lannutti, W. H. Sims, and R. P. Wieckowicz. 173, 1403 (1968)

WIEDENBECK, M. L.
High-Resolution Gamma-Ray Spectroscopic Study of the Decay $^{133}Ba\rightarrow{}^{133}Cs$—D. P. Donnelly, J. J. Reidy, and M. L. Wiedenbeck. 173, 1192 (1968)

WIEDERSICH, H.
Determination of the Nuclear Quadrupole Moment of $Fe^{57m}$ from $\alpha$-$Fe_2O_3$ Data—J. O. Artman, A. H. Muir, Jr., and H. Wiedersich. 173, 337 (1968)

WIENER, E.
Disappearance of a Vibrational Mode in the Ferroelectric Phase Transition of $KH_2PO_4$—Ch. Schenk, E. Wiener, B. Weckermann, and W. Kley. 172, 576 (1968)

WIESE, W. L.
Regularities in Atomic Oscillator Strengths—W. L. Wiese and A. W. Weiss. 175, 50 (1968)

WIEST, J. E.
$2^-$ Isobaric Analog Resonance in the $^{89}Y(p,n_2)^{89}Zr$ Reaction and the Excited States of $^{89}Zr$—G. C. Dutt, F. Gabbard, J. J. Egan, and J. E. Wiest. 176, 1289 (1968)

WIGGINS, T. A.
Stimulated Thermal Rayleigh Scattering in Liquids—C. W. Cho, N. D. Foltz, D. H. Rank, and T. A. Wiggins. 175, 271 (1968)

WILCOX, R. M.
Bounds for the Isothermal, Adiabatic, and Isolated Static Susceptibility Tensors—R. M. Wilcox. 174, 624 (1968)

WILDENTHAL, B. H.
Study of Levels in $^{22}Ne$, $^{26}Mg$, and $^{34}S$ by Proton Pickup—B. H. Wildenthal and E. Newman. 175, 1431 (1968)

WILETS, L.
Erratum: Coupled-State Calculations of Proton-Hydrogen Scattering in the Sturmian Representation—D. F. Gallaher and L. Wilets. [169, 139 (1968)] 176, 423 (1968)

WILHJELM, P.
High-Resolution Study of Isobaric Analog Resonances in $^{23}Na$—G. A. Keyworth, P. Wilhjelm, G. C. Kyker, Jr., H. W. Newson, and E. G. Bilpuch. 176, 1302 (1968)

WILKIN, Colin
High-Energy Proton Scattering and the Structure of Light Nuclei—Robert H. Bassel and Colin Wilkin. 174, 1179 (1968)

WILKINSON, D. H.
Gamma-Ray Decay of the 6.92-, 7.12-, 8.88-, and 13.10-MeV States in $O^{16}$—D. H. Wilkinson, D. E. Alburger, and J. Lowe. 173, 995 (1968)

WILKINSON, David T.
Comment on the Anisotropy of the Primeval Fireball—P. J. E. Peebles and David T. Wilkinson. 174, 2168 (1968)

WILKINSON, E. L.
Spin Relaxation via Low-Lying Energy Level of $Fe^{2+}$ in MgO—E. L. Wilkinson, R. L. Hartman, and J. G. Castle, Jr. 171, 299 (1968)

WILLARD, H. J., Jr.
Ultrasonic Attenuation in the Superconducting State of High-Purity Thallium—H. J. Willard, Jr., R. W. Shaw, and G. L. Salinger. 175, 362 (1968)

Ultrasonic Attenuation in the Normal State of High-Purity Thallium—H. J. Willard, Jr. 175, 367 (1968)

WILLIAMS, E. W.
Electroreflectance Studies of InAs, GaAs, and (Ga,In)As Alloys—E. W. Williams and Victor Rehn. 172, 798 (1968)

WILLIAMS, I. R.
Excitation Functions for Radioactive Isotopes Produced by Proton-Induced Reactions in Silicon—D. W. Sheffey, I. R. Williams, and C. B. Fulmer. 172, 1094 (1968)

WILLIAMS, L. J.
Neutron Diffraction and Susceptibility Study of Dilute La–Rare-Earth Alloys—D. K. Finnemore, L. J. Williams, F. H. Spedding, and D. C. Hopkins. 176, 712 (1968)

WILLIAMS, M. L.
Search for Plasmaron Structure in the Soft X-Ray $L_{2,3}$ Emission Spectrum of Al—J. R. Cuthill, R. C. Dobbyn, A. J. McAlister, and M. L. Williams. 174, 515 (1968)

WILLIAMS, W. S. C.
Measurement of the Branching Ratio for the Decay $K^+ \rightarrow e^+ + \nu_e$—D. R. Botterill, R. M. Brown, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 171, 1402 (1968)
Measurement of the Branching Ratio and Positron Momentum Spectrum for the Decay $K^0 \rightarrow \pi^0 + e^+ + \nu$—D. R. Botterill, R. M. Brown, A. B. Clegg, I. F. Corbett, G. Culligan, J. McL. Emmerson, R. C. Field, J. Garvey, P. B. Jones, N. Middlemas, D. Newton, T. W. Quirk, G. L. Salmon, P. Steinberg, and W. S. C. Williams. 174, 1661 (1968)

WILLIAMSON, C. F.
Intensities and Angular Distributions of Ground-State Rotational Transitions Excited in $(\alpha,3n)$ and $(\alpha,4n)$ Reactions—C. F. Williamson, S. M. Ferguson, B. J. Shepherd, and I. Halpern. 174, 1544 (1968)

WILLIAMSON, R. C.
Velocity of Sound at 1 MHz Near the $He^4$ Critical Point—R. C. Williamson and C. E. Chase. 176, 285 (1968)

WILLIAMSON, W., Jr.
$W^+$-Meson Production—W. Williamson, Jr., and R. T. Deck. 174, 1986 (1968)

WILSON, M.
Configuration Interaction Integrals for Pu I and II—M. Wilson. 171, 4 (1968)
*Ab Initio* Calculation of Screening Effects on $|\Psi(0)|^2$ for Heavy Atoms—M. Wilson. 176, 58 (1968)

WILSON, Richard
Neutron Form Factors from Quasi-Elastic Electron-Deuteron Scattering—R. J. Budnitz, J. Appel, L. Carroll, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. Imrie, C. Mistretta, J. K. Walker, and Richard Wilson. 173, 1357 (1968)
Search for the Electroproduction of the $N'(1470)$ Resonance from Deuterium—J. L. Alberi, J. A. Appel, R. J. Budnitz, J. Chen, J. R. Dunning, Jr., M. Goitein, K. Hanson, D. C. Imrie, C. A. Mistretta, and Richard Wilson. 176, 1631 (1968)

WILSON, Robert S.
Theory of Impurity-Induced Infrared Absorption—Robert S. Wilson, W. T. King, and Shoon K. Kim. 175, 1164 (1968)

WINBOW, G. A.
Complex Angular Momentum and Infinite Helicity Sums. II—G. A. Winbow. 171, 1517 (1968)

WINHOLD, E. J.
Fast-Photoneutron Spectra due to 55–85-MeV Photons—N. N. Kaushal, E. J. Winhold, P. F. Yergin, H. A. Medicus, and R. H. Augustson. 175, 1330 (1968)

WINICOUR, Jeffrey
Static, Axially Symmetric Point Horizons—Jeffrey Winicour, Allen I. Janis, and Ezra T. Newman. 176, 1507 (1968)

WINTERBERG, F.
The Possibility of Producing a Dense Thermonuclear Plasma by an Intense Field Emission Discharge—F. Winterberg. 174, 212 (1968)

WISER, Nathan
Erratum: Phonon-Assisted Tunneling in Bismuth Tunnel Junctions—L. Esaki, L. L. Chang, P. J. Stiles, D. F. O'Kane, and Nathan Wiser. [167, 637 (1968)] 171, 1114 (1968)

WISH, L.
Thermal-Neutron Fission of $^{233}U$: Identification and Fractional Chain Yield of 17-sec $^{77}Ga$—L. Wish. 172, 1262 (1968)

WITTEN, T. R.
Single-Proton Emission Following Positive Pion Absorption in Carbon—T. R. Witten, M. Blecher, and K. Gotow. 174, 1166 (1968)

WITTKOWER, A. B.
Measurement of One- and Two-Electron-Loss Cross Sections for $He^-$ Ions in $H_2$, He, and Ne Gases (400–1500 keV)—G. Ryding, A. B. Wittkower, and P. H. Rose. 174, 149 (1968)

WOLCOTT, N. M.
Ferromagnetism of $CrBe_{13}$—N. M. Wolcott and R. L. Falge, Jr. 171, 591 (1968)

WOLF, W. P.
Erratum: Magnetic Interactions between Rare-Earth Ions in Insulators. I. Accurate Electron-Paramagnetic-Resonance Determination of $Gd^{3+}$ Pair-Interaction Constants in $LaCl_3$—M. T. Hutchings, R. J. Birgeneau, and W. P. Wolf. [168, 1026 (1968)] 176, 1112 (1968)

WOLFF, P. A.
Effect of Nonparabolicity on Light Scattering from Plasmas in Solids—P. A. Wolff. 171, 436 (1968)
Light Scattering from a Plasma in a Magnetic Field—P. M. Platzman, P. A. Wolff, and N. Tzoar. 174, 489 (1968)

WOLGA, G. J.
Two-Quantum Volume Photoelectric Effect in Sodium—M. C. Teich and G. J. Wolga. 171, 809 (1968)

WOLKE, R. L.
Role of Electronic Structure in Determining the Charges of Fast Ions in Matter—R. L. Wolke. 171, 301 (1968)

WOLSKY, G.
Final States with Two or More Strange Particles from 4.25-BeV/$c$ $K^-p$ Interactions—G. S. Abrams, R. G. Glasser, B. Kehoe, B. Sechi-Zorn, and G. Wolsky. 175, 1697 (1968)

WONG, David Y.
Ground State of Three Alpha Particles—J. R. Fulco and D. Y. Wong. 172, 1062 (1968)
Faddeev Equations for Atomic Problems and Solutions for the ($e$, H) System—James S. Ball, Joseph C. Y. Chen, and David Y. Wong. 173, 202 (1968)

WONG, E. Y.
Zeeman Splitting of Vibronic Levels for Octahedral Actinide and Lanthanide Complexes, Free and in Crystals—R. A. Satten, D. R. Johnston, and E. Y. Wong. 171, 370 (1968)

WOO, James W. F.
Erratum: Ultrasonic Attenuation of Pure Strong-Coupling Superconductors—James W. F. Woo. [155, 429 (1967)] 171, 610 (1968)
Longitudinal Ultrasonic Attenuation in Pure Strong-Coupling Superconductors. II.—James W. F. Woo. 172, 423 (1968)

WOOD, P. J.
Free Energy of the Classical Heisenberg Model—R. L. Stephenson and P. J. Wood. 173, 475 (1968)

WOOD, R. E.
Gamma Rays from the Decay of $^{75}Ge$ and $^{77}Ge$—Anne Ng, R. E. Wood, J. M. Palms, P. Venugopala Rao, and R. W. Fink. 176, 1329 (1968)

WOODRUFF, Truman O.
Effects of Current Flow on the Optical Absorption of a Semiconductor—Carl A. Baumgardner and Truman O. Woodruff. 173, 746 (1968)

WOODS, A. D. B.
Lattice Dynamics of Niobium-Molybdenum Alloys—B. M. Powell, P. Martel, and A. D. B. Woods. 171, 727 (1968)

WOOLSEY, Roy B.
Magnon Corrections to the Effective Mass of an Electron in a Magnetic Semiconductor—Robert M. White and Roy B. Woolsey. 176, 908 (1968)

WOOTEN, F.
Optical Properties of Zn—L. P. Mosteller, Jr. and F. Wooten. 171, 743 (1968)
WORLOCK, J. M.
Electric-Field-Induced Raman Scattering in $SrTiO_3$ and $KTaO_3$—P. A. Fleury and J. M. Worlock. 174, 613 (1968)
WORLTON, T. G.
Neutron Diffraction Study of the Magnetic Structure of Hematite to 41 kbar—T. G. Worlton and D. L. Decker. 171, 596 (1968)
WORTIS, Michael
High-Temperature Critical Indices for the Classical Anisotropic Heisenberg Model—David Jasnow and Michael Wortis. 176, 739 (1968)
WORTMAN, D. E.
Analysis of the Ground Term of Triply Ionized Terbium in Calcium Tungstate—D. E. Wortman. 175, 488 (1968)
WORTMAN, W. R.
Two-Pion-Exchange Contributions to Nucleon-Nucleon Scattering—W. R. Wortman. 176, 1762 (1968)
WRAY, J.
Strange-Particle Production in 8-BeV/$c$ Proton-Proton Interactions—M. Firebaugh, G. Ascoli, E. L. Goldwasser, R. D. Sard, and J. Wray. 172, 1354 (1968)
WRIGHT, Byron T.
Angular Distribution of the $d(p,\pi)2p$ Reaction at 45.5 MeV—Demetrius J. Margaziotis, Byron T. Wright, and W. T. H. van Oers. 171, 1170 (1968)
WRIGHT, Jon
Currents as Coordinates in Nonrelativistic Quantum Mechanics—W. J. Pardee, L. Schlessinger, and Jon Wright. 175, 2140 (1968)
WRIGHT, Robert M.
Determination of the Nucleon-Nucleon Scattering Matrix. IX. $(\pi,p)$ Analysis from 7 to 750 MeV—Malcolm H. MacGregor, Richard A. Arndt, and Robert M. Wright. 173, 1272 (1968)
WRIGHT, S. C.
Proton-Neutron Triple Scattering at 425 MeV. I.—S. C. Wright, D. Shawhan, L. Pondrom, S. Olsen, and R. Handler. 175, 1704 (1968)
WU, Chi-Shiang
Self-Consistent Theory of Nuclear Spectra: Pairing-Force Model—Giu Do Dang, R. M. Dreizler, Abraham Klein, and Chi-Shiang Wu. 172, 1022 (1968)
WU, H. L.
Evidence for the $^3\Delta_u$–$B^3\Pi_g$ Transition in $N_2$—H. L. Wu and W. Benesch. 172, 31 (1968)
Erratum: Evidence for the $^3\Delta_u$–$B^3\Pi_g$ Transition in $N_2$—H. L. Wu and W. Benesch. [172, 31 (1968)] 176, 423 (1968)
WU, Tai Tsun
Theory of Toeplitz Determinants and the Spin Correlations of the Two-Dimensional Ising Model. V—Barry M. McCoy and Tai Tsun Wu. 174, 546 (1968)
Theory of a Two-Dimensional Ising Model with Random Impurities. I. Thermodynamics—Barry M. McCoy and Tai Tsun Wu. 176, 631 (1968)
WU, Ta-You
Convergence of the Two-Component Plasma Correlation Function—Y. C. Lee, D. L. Lin, and Ta-You Wu. 172, 145 (1968)
WYLY, L. D.
Directional Correlations in the Decay of $^{148}$Pm—L. D. Wyly, E. T. Patronis, Jr., and C. H. Braden. 172, 1153 (1968)
WYSLING, P.
Stable Potential Minima and the Jahn-Teller Interaction—P. Wysling and K. A. Müller. 173, 327 (1968)
YA'AKOBI, B.
Linear Stark Broadening in High-Density Lithium Plasma—B. Ya'akobi. 176, 227 (1968)
YACOBY, Yizhak
Electrical and Optical Enhancement of Photoconductivity in Semi-Insulating GaAs—Jagdeep Shah and Yizhak Yacoby. 174, 932 (1968)
YAMAMOTO, S. S.
Two-Prong Interaction by $\pi^+ + p$ Collisions at 2.77 BeV/$c$—S. S. Yamamoto and D. C. Rahm. 173, 1302 (1968)
YAMAZAKI, T.
$g$-Factor Measurement of a Three-Particle Isomeric State of $^{208}$Po Following Pulsed Generation in $(\alpha, x\pi)$ Reactions—T. Yamazaki and E. Matthias. 175, 1476 (1968)
YAN, Tung-mow
Form Factors and Electromagnetic Masses—Tung-mow Yan. 171, 1613 (1968)
YANG, C. N.
Model of High-Energy Elastic Scattering and Diffractive Excitation Processes in Hadron-Hadron Collisions—T. T. Chou and C. N. Yang. 175, 1832 (1968)
YANG, T. F.
Semidirect $T$-Forbidden Reaction $^{12}C(d, \alpha)^{10}B_0^*$, $T = 1$—J. Jänecke, T. F. Yang, R. M. Polichar, and W. S. Gray. 175, 1301 (1968)
YAO, Tsu
Emission of Low-Energy Photons in Scattering and Decay Processes and a Possible Method for Determining Electromagnetic Properties of Short-Lived States—Saul Barshay and Tsu Yao. 171, 1708 (1968)
YAO, York-Peng
Quantized Gauge Field Theory of Chiral Symmetry—York-Peng Yao. 171, 1702 (1968)
Decay Mode $\Sigma^0 \to \Lambda^0 + \gamma + \gamma$ and the Magnetic Moment of the $\Sigma^0$—H. S. Mani and York-Peng Yao. 174, 1797 (1968)
Nuclear Effects on the Quasi-Elastic Neutrino Scattering $\nu + n \to \mu^- + p$—York-Peng Yao. 176, 1680 (1968)
YARMUS, Leonard
Electron Spin Resonance of Undiluted Salts in the Parallel Configuration—Leonard Yarmus and Allan A. Harkavy. 173, 427 (1968)
Electron Spin Resonance of $Zn(ClO_4)_2 \cdot 6H_2O{:}Mn^{2+}$ in a Parallel and Perpendicular Configuration—I. J. Fritz and Leonard Yarmus. 173, 445 (1968)
YATES, A. C.
Spin Polarization of Low-Energy Electrons Scattered Elastically from Atoms and Molecules—A. C. Yates. 176, 173 (1968)
YEARIAN, M. R.
Electron Scattering Studies of Calcium and Titanium Isotopes—R. F. Frosch, R. Hofstadter, J. S. McCarthy, G. K. Nöldeke, K. J. van Oostrum, M. R. Yearian, B. C. Clark, R. Herman, and D. G. Ravenhall. 174, 1380 (1968)
YEE, B. G. W.
Magnetic Field Dependence of the Velocity of Sound in Ultrapure Cd and Cu—B. G. W. Yee and J. D. Gavenda. 175, 805 (1968)
YEE, D. D. H.
Nonexistence of Self-Conjugate Particles with Half-Integral Isospin—D. D. H. Yee. 172, 1537 (1968)
Wave Equations for Neutral Particles of Arbitrary Spin—D. D. H. Yee. 172, 1539 (1968)
YEKUTIELI, G.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6.92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)

Study of the Λ-$N$ System in Low-Energy Λ-$p$ Elastic Scattering—G. Alexander, U. Karshon, A. Shapira, G. Yekutieli, R. Engelmann, H. Filthuth, and W. Lughofer. 173, 1452 (1968)

YEM, Pham xuan
Pion Electromagnetic Form Factor—Tran N. Truong, R. Vinh Mau, and Pham xuan Yem. 172, 1645 (1968)

YEN, E.
Resonance Production in Proton-Proton Scattering at 12.5 and 30 BeV/$c$—E. Yen. 175, 1982 (1968)

YEN, W. L.
Compilation of $\pi^- p$ Data at 4 GeV/$c$: Backward Resonance Production and $\pi\pi$ Scattering—P. B. Johnson, J. A. Poirier, N. N. Biswas, N. M. Cason, T. H. Groves, V. P. Kenney, J. T. McGahan, W. D. Shephard, L. J. Gutay, J. H. Campbell, R. L. Eisner, F. J. Loeffler, R. E. Peters, R. J. Sahni, W. L. Yen, I. Derado, and Z. G. T. Guiragossián. 176, 1651 (1968)

YENNIE, D. R.
Coulomb Interference in High-Energy Scattering—Geoffrey B. West and D. R. Yennie. 172, 1413 (1968)

YERGIN, P. F.
Fast-Photoneutron Spectra due to 55–85-MeV Photons—N. N. Kaushal, E. J. Winhold, P. F. Yergin, H. A. Medicus, and R. H. Augustson. 175, 1330 (1968)

YERKE, R. L.
$^{16}O(\alpha,2\alpha)^{12}C_{g.s.}$ Reaction Mechanisms near 25 MeV—A. W. Parker, J. S. Allen, R. L. Yerke, and V. G. Stotland. 174, 1093 (1968)

YING, S. C.
Fermi-Liquid Effects on Plasma Wave Propagation in Metals—S. C. Ying and J. J. Quinn. 173, 473 (1968)

YIP, Sidney
Rotational Correlation Functions in Neutron Scattering by Molecular Gases—Ashok K. Agrawal and Sidney Yip. 171, 263 (1968)

YNTEMA, J. L.
Study of the $Na^{23}(He^3,d)Mg^{24}$ Reaction—R. C. Bearse and J. L. Yntema. 175, 1442 (1968)
Experimental Study of the ($d$,$He^3$) Reaction on Even-$A$ Isotopes of Mo—H. Ohnuma and J. L. Yntema. 176, 1416 (1968)

YOCK, P. C. M.
Two-Pion-Exchange Theory. Nucleon-Nucleon Scattering—P. C. M. Yock. 172, 1844 (1968)

YODER, N. R.
Nucleon-Nucleon Models, Charge Splitting, and the Nucleon-Nucleon Data near 210 MeV—M. D. Miller, P. S. Signell, and N. R. Yoder. 176, 1724 (1968)

YORK, C. M.
Elastic Scattering of 14-MeV Neutrons by Deuterons—A. C. Berick, R. A. J. Riddle, and C. M. York. 174, 1105 (1968)

YOSHIDA, K.
Chiral Symmetry from Divergence Requirements—D. B. Fairlie and K. Yoshida. 174, 1816 (1968)

YOSHIMURA, M.
Theory of Currents, $\sigma$ Model, and the Spherical Top in the Internal Space—H. Sugawara and M. Yoshimura. 173, 1419 (1968)

YOUNG, A. M.
Reaction $T(^3He,\gamma)^6Li$ in the Energy Range 0.5-11 MeV—S. L. Blatt, A. M. Young, S. C. Ling, K. J. Moon, and C. D. Porterfield. 176, 1147 (1968)

YOUNG, B. A.
Modified Orbach Relaxation Process in a $La(Cl, Br)_3$ Matrix—B. A. Young and H. J. Stapleton. 176, 502 (1968)

YOUNG, J. E.
Relativistic Three-Body Theory with Applications to $\pi$-$N$ Scattering—R. Aaron, R. D. Amado, and J. E. Young. 174, 2022 (1968)

YOUNG, P. G.
Search for the Ground State of $^5H$ by means of the $^3H(t,p)$ Reaction—P. G. Young, Richard H. Stokes, and Gerald G. Ohlsen. 173, 949 (1968)
Search for States in the Three-Neutron and Triton Systems—Gerald G. Ohlsen, Richard H. Stokes, and P. G. Young. 176, 1163 (1968)

YOUNG, Richard A.
Influence of Localized Umklapp Scattering on the Galvanomagnetic Properties of Metals—Richard A. Young. 175, 813 (1968)

YOUNG, Robin A.
Lyman-$\alpha$ Production and Polarization in $He^+$ Collisions with H and $H_2$—Robin A. Young, R. F. Stebbings, and J. William McGowan. 171, 85 (1968)

YOUNG, T. M.
$^{40}Ar(p,n)^{40}K$ Reaction from Threshold to 5.0 MeV—T. M. Young, J. D. Brandenberger, and F. Gabbard. 172, 1148 (1968)

YOUNGBLOOD, D. H.
Gamma Decay of $T=\frac{3}{2}$ States in $Al^{25}$ and $P^{29}$—G. C. Morrison, D. H. Youngblood, R. C. Bearse, and R. E. Segel. 174, 1366 (1968)

YU, A. Y-C.
Optical Properties of Platinum—A. Y-C. Yu, W. E. Spicer, and G. Hass. 171, 834 (1968)
Erratum: Photoemission Studies of the Electronic Structure of Cobalt—A. Y-C. Yu and W. E. Spicer. [167, 674 (1968)] 172, 1002 (1968)
Erratum: Optical Properties of Cobalt—A. Y-C. Yu, T. M. Donovan, and W. E. Spicer. [167, 670 (1968)] 172, 1002 (1968)

YUEN, Horace
Quantum Noise. XIII. Six-Classical-Variable Description of Quantum Laser Fluctuations—Melvin Lax and Horace Yuen. 172, 362 (1968)

YUEN, P. S.
Angular Forces in the Lattice Dynamics of Face-Centered Cubic Metals. II—Y. P. Varshni and P. S. Yuen. 174, 766 (1968)

YUN, Suk Koo
Vector and Axial-Vector Meson Dominance in the $K_{3\pi}$ Decays—R. H. Graham and S. K. Yun. 171, 1550 (1968)
Two-Pole Model for the $\eta_{3\pi}$ Decays—Suk Koo Yun. 173, 1764 (1968)

ZACHARIASEN, Fredrik
Field-Theoretic Formulation of the Bootstrap Hypothesis—P. Kaus and F. Zachariasen. 171, 1597 (1968)
Crossing-Symmetric Rising Regge Trajectories—Shu-Yuan Chu, Gary Epstein, Peter E. Kaus, Richard C. Slansky, and Fredrik Zachariasen. 175, 2098 (1968)

ZAIDI, Haider R.
Calculation of Resonance Broadening—Haider R. Zaidi. 173, 123 (1968)
Electron Broadening of Isolated Spectral Lines—Haider R. Zaidi. 173, 132 (1968)

ZALLEN, Richard
Symmetry and Reststrahlen in Elemental Crystals—Richard Zallen. 173, 824 (1968)
Optical Phonons and Dynamic Charge in Trigonal Se and Te—Inan Chen and Richard Zallen. 173, 833 (1968)

ZEBOUNI, N. H.
Lattice Thermal Conductivity, Nernst-Ettinghausen Effect, and Specific Heat in Antimony at Low Temperature—R. S. Blewer, N. H. Zebouni, and C. G. Grenier. 174, 700 (1968)
ZECH, C.
Elastic Scattering and Single-Pion Production in Proton-Proton Interactions at 6 92 BeV/$c$—G. Alexander, Z. Carmel, Y. Eisenberg, E. E. Ronat, A. Shapira, G. Yekutieli, A. Fridman, G. Maurer, J. Oudet, C. Zech, and P. Cüer. 173, 1322 (1968)
ZEE, A.
Rate of $A_1 \to \rho\pi$ from Asymptotic Chiral Symmetry—A. Zee. 173, 1788 (1968)
ZEISSE, Carl R.
Low Temperature Measurements of the $He^3$ and $He^4$ Melting Curves—Carl R. Zeisse. 173, 301 (1968)
ZERBY, C. D.
Photoelectric Cross Sections in the keV Range—H. Brysk and C. D. Zerby. 171, 292 (1968)
ZERNIK, Wolfgang
Multiphoton Ionization of Atomic Hydrogen—Wolfgang Zernik. 176, 420 (1968)
ZETTA, L.
Theoretical Calculations of Statistical Heavy-Ion Reactions—E. Gadioli, I. Iori, and L. Zetta. 174, 1140 (1968)
ZIMÁNYI, J.
Shape of the Nuclear Symmetry Potential—J. Zimányi and B. Gyarmati. 174, 1112 (1968)
ZINIKER, William M.
Faraday Rotation of the CaO $F$ Band and 3557 Å Zero-Phonon Peak—James C. Kemp, William M. Ziniker, James A. Glaze, and Jack C. Cheng. 171, 1024 (1968)
ZINK, J. W.
Shell Structure and the Thomas-Fermi Equation of State—J. W. Zink. 176, 279 (1968)
ZIPF, T. F.
Search for New Particles Produced by High-Energy Photons—A. Barna, J. Cox, F. Martin, M. L. Perl, T. H. Tan, W. T. Toner, T. F. Zipf, and E. H. Bellamy. 173, 1391 (1968)
ZOLLER, Paul
Specific Heat of a Spherical Type-II Superconductor—Paul Zoller and J. R. Dillinger. 172, 390 (1968)
ZUCKERMAN, M. J.
Vibrational Modes of a Negative Ion in Liquid Helium—V. Celli, Morrel H. Cohen, and M. J. Zuckerman. 173, 253 (1968)
ZUPANCIC, I.
Nuclear-Magnetic-Resonance Study of the Ferroelectric Transitions in $NaH_3(SeO_3)_2$ and $NaD_3(SeO_3)_2$—R. Blinc, J. Stepisnik, and I. Zupančič. 176, 732 (1968)
ZURMÜHLE, R. W.
($^3He,\alpha$) Reaction on $^{89}Y$ and $^{86}Kr$ at 18 MeV—C. M. Fou and R. W. Zurmühle. 176, 1339 (1968)
ZWANZIGER, Daniel
Exactly Soluble Nonrelativistic Model of Particles with Both Electric and Magnetic Charges—Daniel Zwanziger. 176, 1480 (1968)
Quantum Field Theory of Particles with Both Electric and Magnetic Charges—Daniel Zwanziger. 176, 1489 (1968)

# AMERICAN INSTITUTE OF PHYSICS

335 East 45 Street New York, New York 10017

THE American Institute of Physics was founded in 1931 as a federation of leading societies in the field of Physics. It combines into one operating agency those functions on behalf of physics that can best be done by the Societies jointly. Its purpose is the advancement and diffusion of the knowledge of physics and its application to human welfare. To this end, it publishes for itself or the Societies the 16 journals listed on this page, as well as the 13 translations of Soviet journals; promotes unity and effectiveness of effort among all who are interested in physics; renders numerous direct services to physicists and to the public; and cooperates with government agencies, national associations, educational institutions, technical industries, and others in such manner as to realize the opportunities and fulfill the responsibilities of physics as an important and constructive human activity.

**MEMBER SOCIETIES:**

**The American Physical Society**
W. W. HAVENS, JR., *Executive Secretary*, 335 East 45 Street, New York, N. Y. 10017

**Optical Society of America**
MARY WARGA, *Executive Secretary*, 2100 Pennsylvania Avenue NW, Washington, D. C. 20037

**Acoustical Society of America**
WALLACE WATERFALL, *Secretary*, 335 East 45 Street, New York, N. Y. 10017

**Society of Rheology**
JOHN C. MILLER, *Secretary-Treasurer*, Union Carbide Plastics Co., Bound Brook, N. J. 08805

**American Association of Physics Teachers**
ALFRED ROMER, *Secretary*, St. Lawrence University, Canton, N. Y. 13617

**American Crystallographic Association**
WILLIAM L. KEHL, *Secretary*, Gulf Research & Development Co., P.O. Box 2038, Pittsburgh, Pa.

**American Astronomical Society**
G. C. MCVITTIE, *Secretary*, University of Illinois Observatory, Urbana, Ill.

**AFFILIATED SOCIETIES:** American Association of Physicists in Medicine · American Institute of Aeronautics and Astronautics · American Society for Metals · American Vacuum Society · Cleveland Physics Society · Division of Physical Chemistry of ACS · Electron Microscopy Society of America · Geological Society of America · Instrument Society of America · Nuclear Science Group of IEEE · Philosophical Society of Washington · Physical Society of Pittsburgh · Physics Club of Chicago · Physics Club of Lehigh Valley · Physics Club of Milwaukee · Physics Club of New York · Physics Club of Philadelphia · Physics Club of Richmond · Society for Applied Spectroscopy

**CORPORATE ASSOCIATES:** Over 150 leading industrial enterprises and other institutions which contribute to the support of the Institute.

**JOURNALS:**

**The Physical Review** • S. PASTERNACK; A. W. K. METZNER; J. R. ROEDER, *Editors*, Brookhaven National Laboratory, Upton, Long Island, N. Y. 11973

**Reviews of Modern Physics** • E. U. CONDON, *Editor*, Joint Institute for Laboratory Astrophysics, University of Colorado, Boulder, Colo. 80302

**Journal of the Optical Society of America** • DAVID L. MAC ADAM, *Editor*, 68 Hammond Street, Rochester, N. Y. 14615

**The Journal of the Acoustical Society of America** • R. BRUCE LINDSAY, *Editor*, Department of Physics, Brown University, Providence, R. I. 02912

**American Journal of Physics** • FOREST I. BOLEY, *Editor*, Department of Physics, Dartmouth College, Hanover, N. H. 03755

**The Journal of Vacuum Science and Technology** • FRANKLIN M. PROPST, *Editor*, Coordinated Science Laboratory, University of Illinois, Urbana, Ill. 61803

**The Review of Scientific Instruments** • J. B. HORNER KUPER, *Editor*, Brookhaven National Laboratory, Upton, Long Island, N. Y. 11973

**The Journal of Chemical Physics** • J. W. STOUT, *Editor*, Department of Chemistry, The University of Chicago, Chicago, Ill. 60637

**Journal of Applied Physics** • FRANK E. MYERS, *Editor*, Argonne National Laboratory, Box 296, Argonne, Ill. 60440

**Physics Today** • R. HOBART ELLIS, *Editor*, American Institute of Physics, 335 East 45 Street, New York, N. Y. 10017

**The Physics of Fluids** • FRANÇOIS N. FRENKIEL, *Editor*, Applied Mathematics Laboratory, Naval Ship Research and Development Center, Washington, D. C. 20007

**Journal of Mathematical Physics** • ELLIOTT W. MONTROLL, *Editor*, Physics Department, University of Rochester, Rochester, N. Y. 14627

**The Astronomical Journal** • L. WOLTJER AND N. H. BAKER, *Editors*, Department of Astronomy, Columbia University, New York, N. Y. 10027

**Applied Physics Letters** • FRANK E. MYERS, *Editor*, Argonne National Laboratory, Box 296, Argonne, Ill. 60440

**Applied Optics** • JOHN N. HOWARD, *Editor*, Air Force Cambridge Research Laboratories, Bedford, Mass. 01730

**Applied Spectroscopy** • JOHN R. FERRARO, *Editor*, Chemistry Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Ill. 60440

**TRANSLATION JOURNALS:**

**Soviet Physics—JETP**
**Soviet Physics—Solid State**
**Soviet Physics—Technical Physics**
**Soviet Physics—Doklady**
**JETP Letters**
**Optics and Spectroscopy**
**Soviet Physics—Semiconductors**
**Soviet Physics—Acoustics**
**Soviet Physics—Crystallography**
**Soviet Physics—Uspekhi**
**Soviet Astronomy—AJ**
**Soviet Journal of Nuclear Physics**
**Soviet Journal of Optical Technology**

**GOVERNING BOARD**

Ralph A. Sawyer, *Chairman*
Luis W. Alvarez
Arnold Arons
Stanley S. Ballard
John Bardeen
H. Richard Crane
Herbert J. Fusfeld
Ronald Geballe
J. E. Goldman
S. A. Goudsmit
W. W. Havens, Jr.
Karl G. Kessler
R. Bruce Lindsay
A. I. Mahan
Vincent E. Parker
S. L. Quimby
Paul M. Routly
Isadore Rudnick
Robert G. Sachs
Frederick Seitz
Robert S. Shankland
Thor L. Smith
A. Francis Turner
Mary E. Warga
Wallace Waterfall
A. E. Whitford
Elizabeth A. Wood
Clarence Zener

**GENERAL ADMINISTRATION**

H. William Koch
*Director*
Wallace Waterfall
*Secretary*
Gerald F. Gilbert
*Treasurer and Controller*
Lewis Slack
*Associate Director, General Activities*
Kathryn Setze
*Assistant Treasurer*
Emily Wolf
*Society Services Manager*
Dwight E. Gray
*Washington Representative*

**DIRECTORS OF PROFESSIONAL DIVISIONS**

Hugh C. Wolfe
*Publications*
Arthur Herschman
*Information*
Eugene H. Kone
*Public Relations*
Charles Weiner
*Physics History*
A. A. Strassenburg
*Education and Manpower*
R. H. Ellis, Jr.
*Physics Today*

**PUBLISHING OPERATIONS**

Theodore Vorburger
*Advertising Manager*
David B. Biesel
*Editorial Manager*
Rosalind Nissim
*Assistant Editorial Manager*
John Di Caro
*Fulfillment Manager*
Karen Lund
*Accounting Manager*
Margaret R. Pavin
*Supervisor, Journal Publications*

*Senior Copy Editors*
David Ganz
Joel Shimberg
Jo-Ann Wasserman

*Copy Editors at AIP*
D. R. Hathwell
C. M. McLaughlin
B. A. Weismann

2-18-69

## CONTENTS

THE PHYSICAL REVIEW SECOND SERIES, VOLUME 176, INDEX DECEMBER 1968

Analytic Subject Index for 1968 . . . . . 2169
Alphabetical Subject Index . . . . . 2171
Announcement: Comments and Addenda . . . . . 2173
Announcement . . . . . 2174
Analytic Subject Index to Volume 176 . . . . . 2175
Author Index to Volume 176 . . . . . 2241
Abstracts of Articles in Volume 176 . . . . . A1

LANCASTER PRESS, INC., LANCASTER, PA.